OPEN ACCESS
Saudi Journal of Medical and Pharmaceutical Sciences
Abbreviated Key Title: Saudi J Med Pharm Sci
ISSN 2413-4929 (Print) |ISSN 2413-4910 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com/journal/sjmps/home

Original Research Article

Comparison of Greyscale and Doppler Ultrasound with Shear wave Elastography (SWE) in the Diagnosis of Liver Cirrhosis

Dr. Ayesha Zubair[1*], Dr. Asma Yaseen[1], Dr Yusra Shehzadi[1], Dr. Romaiza Sagheer[1], Dr. Aisha Saleem[1], Dr Raham Bacha[2], Dr. Syed Amir Gilani[3], S. Muhammad Yousaf Farooq[4], Dr. Zeeshan Rashid Mirza[5]
[1]Student of MID, The University of Lahore, Pakistan
[2]PhD, M.Phil. Ultrasound, The University of Lahore, Pakistan
[3]Professor, PhD Ultrasound, The University of Lahore, Pakistan
[4]M.Phil. Ultrasound, The University of Lahore, Pakistan
[5]MBBS, MCPS, FCPS, EDIR, HOD of INMOL Hospital, Lahore, Pakistan

***Corresponding author:** Dr. Ayesha Zubair
| **Received:** 26.01.2019 | **Accepted:** 05.02.2019 | **Published:** 13.02.2019
DOI: 10.36348/sjmps.2019.v05i02.002

Abstract

Liver cirrhosis is a life-threatening disease and quick diagnosis of liver cirrhosis is important. Liver Biopsy is considered a gold standard method for the diagnosis of liver cirrhosis. However, it is an invasive method. Basic imaging and non-invasive methods have been developed over the last few decades for the detection of liver cirrhosis. The aim of our research is to compare shear wave elastography with greyscale and Doppler ultrasonography for better treatment and diagnosis of Liver Cirrhosis. One-ninety-five (195) patients were selected at INMOL Hospital, Lahore radiology department suffering from cirrhosis. On Shear Wave Elastography (SWE) Elasticity and Stiffness were mean 21.76±9.00 Kpa (10.50 to 72.3 Kpa) and Shear-wave Velocity Mode was mean 2.578±0.4766 cm/s (2.08 to 4.86) cm/s. This study showed that the greyscale and Doppler ultrasonography alone is not enough for the detection of Liver cirrhosis and Shear wave elastography (SWE) is the more accurate and best method for the detection of Liver Cirrhosis.
Keywords: Liver Disease, Liver Cirrhosis, Liver Biopsy, Greyscale Ultrasonography, Doppler Ultrasonography, Shear Wave Elastography.

INTRODUCTION

Liver cirrhosis is the end stage of chronic liver disease. It is caused by diffuse fibrosis and regenerating nodules that result from continual necrosis of liver cell and degeneration. It is recognized as an associate irreversible type of parenchymal fibrosis. Liver cirrhosis reduce hepatic functions and lead to multiple complications [1]. Early identification of liver cirrhosis and quantification of the proportion of fibrosis in the liver is very important in the management of chronic liver disease. Prognosis and management of chronic liver diseases hinge powerfully on the quantity and progression of liver fibrosis [2, 3].

Liver cirrhosis is assessed according to the main location of fibrosis occurrence [4]. The exact prevalence of cirrhosis worldwide is unknown. Pakistan is known as the cirrhotic state [5]. One hundred and seventy million people are infected with hepatitis C out of which 70% have chronic hepatitis and 15 to 20% will develop cirrhosis and its consequences [6]. Similar numbers have been reported from Europe and numbers are even higher in most Asian and African countries where chronic viral hepatitis B or C are frequent [7]. Chronic hepatitis B is the primary cause of liver cirrhosis in the Asia Pacific region [8, 9].

Liver biopsy (LB) is still considered the gold standard in the evaluation of liver fibrosis, even though it is invasive, painful, costly, and with limitations in diagnostic use and accuracy. The accuracy of LB in assessing liver fibrosis is influenced by many factors, such as sampling error as well as intra- and interobserver variability. Given these limitations, LB is not an ideal method for repeated assessment of disease progression. Following not only the progression but also the regression of liver fibrosis over time could be of clinical significance, because research has demonstrated a reduction in liver fibrosis with treatment, even in advanced stages. These limitations of the LB have motivated research for noninvasive methods of measuring liver fibrosis [10].

Progressive histological stages of fibrosis have been defined in the process leading to the development of cirrhosis. Among the more common staging systems,

the METAVIR scale is distinguished by four stages, with stage F0 (representing lack of fibrosis), stage F1 (portal fibrosis), stage F2 (peri-portal fibrosis) stage F3 (bridging fibrosis) and finally stage F4 (representing cirrhosis) [11].

In clinical practice, the severity of liver cirrhosis is measured by multiple serologic biomarkers and many clinical scores and panels, such as the Child-Pugh score, model for end-stage liver disease score, Fibro Test, HepaScore, FibroSpect, enhanced liver fibrosis score, and aspartate aminotransferase-to-platelet ratio index. However, these metrics also have many limitations, since the biomarkers are not liver-specific and measurement depends highly on their clearance and excretion [12].

The classical role of many imaging modalities in liver cirrhosis diagnosis is the detection of morphological changes in the liver [13]. Ultrasonography provides important information on hepatic architecture, is cheap and widely available. Nodularity and increased echogenicity of the liver are often found in cirrhosis but are also present in steatosis [14]. Studies showed an overall sensitivity to chronic liver disease of 65%-95%, with a positive predictive value of 98%. The most indicative finding of liver cirrhosis was nodular surface. It was also more sensitive in a high-frequency probe [15].

In cirrhosis, Doppler waves of the hepatic vein show a spectral broadening and hepatic vein narrowing [16]. The portal vein is initially dilated over 1.4 cm in diameter, but the emergence of the bypass collateral vessels changes hepatofugal blood flow and decreases the portal vein diameter to less than 1 cm [17, 18]. Development of contrast materials using micro-bubbles can help measure the blood transit time of the liver. However, these studies showed no significant correlation between the severity of hepatic fibrosis and hemodynamic coefficients including hepatic vein transit time, hepatic artery transit time and intrahepatic transit time [19].

Elasticity measurement (FibroScan) is a promising technique based on the velocity of an elastic wave via an intercostally placed transmitter. It is relative a new technology, but not available everywhere. Shear wave velocity is determined by pulse ultrasound and correlates with liver stiffness, i.e., fibrosis. The examination is limited by morbid obesity, ascites and small intercostal spaces [20]. Shear-wave elastography (SWE) can be used to stage hepatic fibrosis [21]. Few studies have shown that LSM (Liver Stiffness Measurement) is acceptable diagnostic accuracy for detecting early compensated cirrhosis in CHB [22]. The 2D-SWE showed good diagnostic accuracy in staging liver fibrosis in patients with CHB (Chronic Hepatitis B) infection and assisted in excluding liver fibrosis and cirrhosis [23].

MATERIALS AND METHODS

The cross-sectional comparative analytical study was conducted for 195 patients who were selected randomly at Institute of Nuclear Medicine & Oncology Lahore (INMOL), radiology department. 195 patients were included after approval of synopsis from Institutional Review Board (IRB).

Sampling Technique

Inclusion Criteria

All patients were cirrhotic and referred for Greyscale, Doppler Ultrasonography and Shear wave elastography.

Machine

TOSHIBA APLIO 500 with superficial transducer frequency range 2-5 MHz was used for this study. For greyscale imaging patient was supine. The right intercostal approach was used for the examination of the liver. Spleen length was measured in the longitudinal axis during inspiration in the supine position. Splenomegaly was defined as the measured spleen length greater than or equal to 13 cm. (Figure-1) Doppler ultrasound examinations were obtained using a right lateral intercostal approach. Peak velocity of the portal vein (PV) was measured in cm per second at the porta hepatis using a Doppler angle of less than or equal to 60° for angle correction. (Figure-2) For shear wave elastography (SWE) the xiphoid sternum was palpated initially and the 6C1 curvilinear transducer was placed on the right lateral rib cage at this anatomical level. The liver was imaged via a right intercostal approach and measurements was taken from segments 5/7/8 of the liver. Shear wave frequency was set to 2.2 MHz with a tracking frequency of 0. The elastogram was set to a box size of 2.5 × 3 cm with a 10 mm to 13mm circle ROI. A maximum of ten to thirteen ROIs was placed within the elastogram at a similar liver depth. (Figure 3&4) Data has been estimated and analyzed with SPSS version 24. The quantitative data (Age, gender,) was given by descriptive statistic's form, mean ±S.D; however qualitative data was given by percentage, frequency and bar charts or pie charts. Collected data had saved in Microsoft office.

RESULTS

One-ninety-five patients were selected suffering from cirrhosis with mean age 49.75 ± 11.04 years (Table-2). On greyscale Ultrasonography the Liver size of 23 (11.8) patients was enlarged, 143 (73.3%) normal, 8 (4.1) small, 3(1.5%) were mildly enlarged, 18(9.2%) were shrunken (Table-1 & Graph-1). The hepatic echotexture was coarse for all cirrhotic patients 195 (100%) (Table-1, Graph-1).The margins of the liver were irregular for all cirrhotic patients 195 (100%).

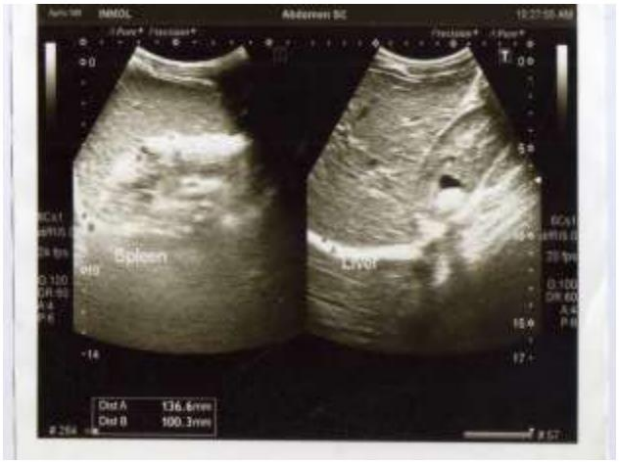


Fig-1: Shows Coarse and Nodular Echotexture, Surface Irregularity, Normal size of liver 13.6cm and Spleen size 10.3cm on Greyscale Ultrasonography

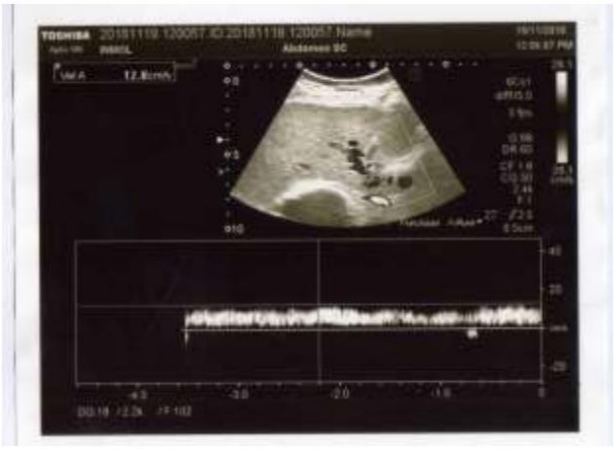


Fig-2: Shows the main portal vein velocity measuring 12.8cm/s on Doppler US

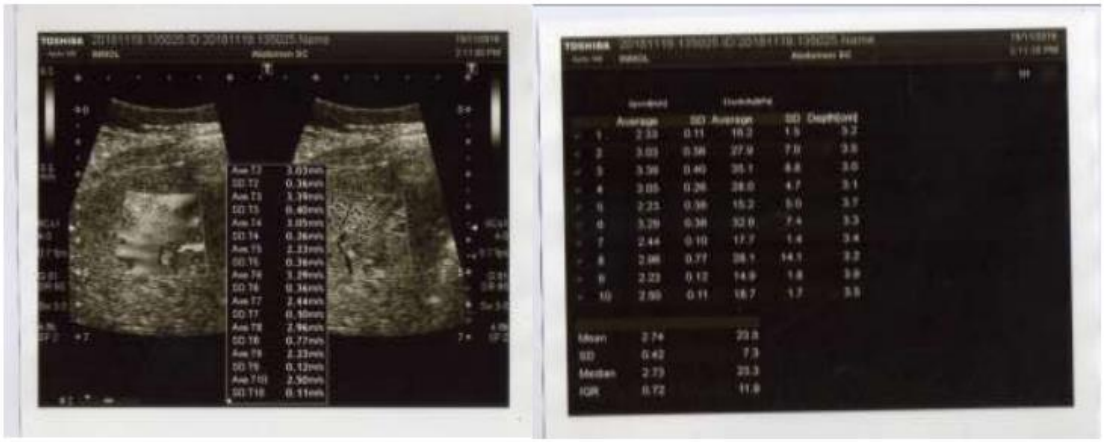
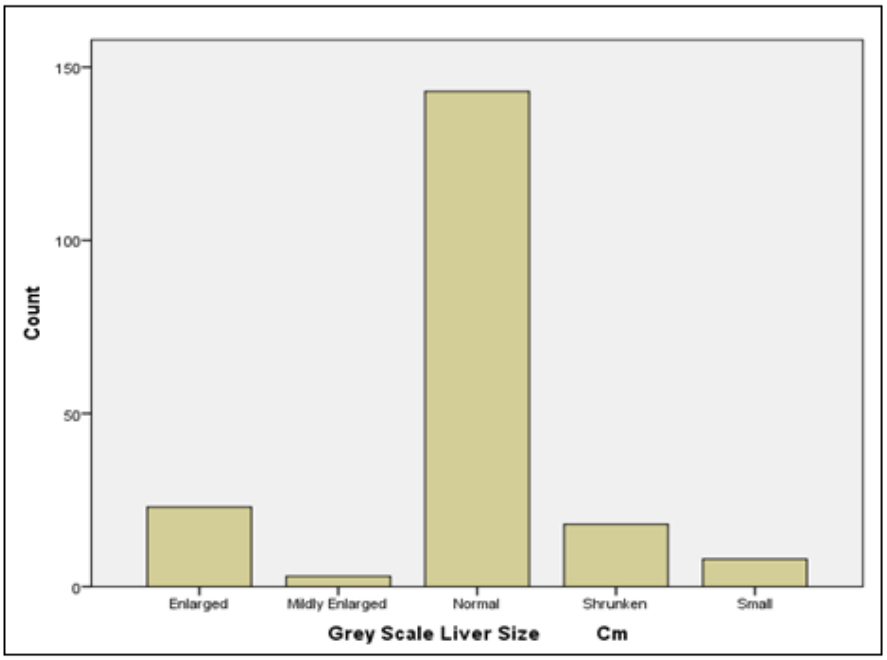


Fig-3&4: Shear wave elastography images shows that 10 ROIs are used on the Left lobe of the liver and giving us an average of 10 values. Mean SWE velocity mode is 2.74 cm/s and the average value of Liver elasticity is 23.3Kpa with an average depth of 2.6cm

Table-1: Results

	Frequency	Percent
Liver Sizes		
Enlarged	23	11.8
Mildly Enlarged	3	1.5
Normal	143	73.3
Small	8	4.1
Shrunken	18	9.2
Liver Echotexture	195	100.0
Liver Margins	195	100.0
METAVIR Score	195	100.0
Cirrhosis(Severe Fibrosis)	195	100.0
Total	195	100.0



Graph-1: Greyscale Liver margins

Table-2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std.Deviation
Age	195	27.00	80.00	49.7538	11.04214
Main Doppler Velocity Portal vein	195	7.00	28.00	15.2118	3.53036
SWE Velocity mode cm/s	195	2.08	4.86	2.5781	.47666
Spleen Size	195	6.00	19.00	12.7626	2.50078
SWE Elasticity/Stiffness	195	10.5	72.30	21.7697	9.00731
Portal Vein Diameter	195	6.80	17.00	11.0072	2.30862

(Figure-1) (Table-1 & Graph-1) Spleen size was mean 12.76 ± 2.500 cm (6.00 to 19.00 cm) (Table-2). On Doppler Ultrasonography We found that the main portal vein velocity was mean 15.21 ±3.53 cm/s, (7.00 to 28 cm). (Table-2) and portal vein diameter was mean 11.00 ± 2.30 mm, (6.8 to 17mm) (Figure-2) (Table-2). On Shear wave elastography the shear wave Elasticity and Stiffness were mean 21.76±9.00 Kpa (10.50 to 72.3 Kpa) (Table-2 & Graph-2) and Shear-wave Velocity Mode was mean 2.578±0.4766 cm/s (2.08 to 4.86) cm/s (Table-2). According to METAVIR staging system, all patients were scoring F4 cirrhotic showing severe fibrosis (Table-1), (Figure 3&4).

DISCUSSION

Liver cirrhosis has emerged as a major cause of global health burden. It is caused by diffuse fibrosis and regenerating nodules that result from continual necrosis of liver cell and degeneration [1]. Deaths caused by liver cirrhosis have been increased over the past years [24]. The exact prevalence of cirrhosis worldwide is unknown. Pakistan is known as the cirrhotic state [5]. One hundred and seventy million people are infected with hepatitis C out of which 70%

have chronic hepatitis and 15 to 20% will develop cirrhosis and its consequences [6]. Chronic hepatitis B is the primary cause of liver cirrhosis in the Asia-Pacific region [9]. Liver Biopsy is an invasive and expensive procedure for the detection of Liver Cirrhosis. It also has few limitations and its sampling bias limit the applicability of the method. However, it is considered a gold standard method for the detection of Liver Cirrhosis. Its limitations have forced the researchers for looking noninvasive methods for Liver Cirrhosis [10]. Basic imaging modalities have been introduced. Greyscale Ultrasonography has an advantage of being an inexpensive, versatile and widely available modality that can be used at the bedside at any time. Liver Cirrhosis is characterized by surface irregularity, accentuation of the fissure, heterogeneity, bright and coarsening of the hepatic architecture, cirrhotic nodules (Figure-1). Nodularity and increased echogenicity of the liver are often found in cirrhosis but are also present in steatosis [14]. Studies showed an overall sensitivity to chronic liver disease of 65%-95%, with a positive predictive value of 98% [15]. Although greyscale Ultrasonography alone is not enough and any single feature is not sensitive in the detection of liver Cirrhosis [4]. Doppler Ultrasonography has widely used imaging modality. The portal vein is initially dilated over 1.4 cm in diameter, but the emergence of the bypass collateral vessels changes hepatofugal blood flow and decreases the portal vein diameter to less than 1 cm [17, 18]. The main Portal vein velocity alone is not enough in the detection of Liver Cirrhosis. Development of contrast materials using micro-bubbles can help measure the blood transit time of the liver. However, these studies had shown no significance correlation [19].

Shear wave elastography is a noninvasive, easy and realistic method and a promising technique for the detection of Liver Cirrhosis. The shear wave velocity is directly related to Liver Stiffness. The examination is limited by morbid obesity, ascites and small intercostal spaces [20]. However, it is expensive and relatively a new technology. The 2D-SWE showed good diagnostic accuracy in staging liver fibrosis in patients with CHB (Chronic Hepatitis B) infection and assisted in excluding liver fibrosis and cirrhosis [23]. In this procedure, external pressure is applied to harder tissues than the soft ones. The normal value of liver stiffness is 2.6 to 6.2 Kpa [25]. In SWE Elasticity and Stiffness were mean 21.76±9.00 Kpa (10.50 to 72.3 Kpa) (Table-2) and Shear-wave Velocity Mode was mean 2.578±0.4766 cm/s (2.08 to 4.86) cm/s (Table-2) for cirrhotic patients and METAVIR scoring for these patients are F4 which recommend cirrhosis with severe fibrosis (Table-1).

CONCLUSION

It was concluded from this study that Shear Wave Elastography is more accurate in the diagnosis of Liver Cirrhosis as compare to Greyscale and Doppler Ultrasonography.

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