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Ultrasound elastography and MR elastography for assessing liver fibrosis

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Abstract
Background: Liver fibrosis is a common result of many chronic liver diseases and if progressive leads to cirrhosis. The present study was conducted to compare the ultrasound elastography and MR Elastography for assessing liver fibrosis.
Material and Methods: The present study 100 patients with diagnosed liver fibrosis were included in the study. The clinically obtained biopsy specimen was reviewed by single person and scored the histologic features using the NASH Clinical Research Network histologic scoring system. The pathologist was blinded to imaging data. Sonographers were blinded to clinical, histological, and MRI data. MR analysts were blinded to clinical, histological, and ultrasound data. The Statistical difference was assessed and statistical significance was assessed at a type I error rate of 0.05.
Results: In the present study on histopathogical examination it was found that in total, 45, 37, 4, 9 and 5 had fibrosis stages 0, 1, 2, 3 and 4 respectively. The Accuracy of MRE was significantly higher than those of SWE for diagnosing any fibrosis.
Conclusion: The present study concluded that MR Elastography was better than ultrasound elastography for assessing liver fibrosis.

Keywords: MR elastography, ultrasound elastography, liver fibrosis

Introduction

Chronic liver diseases are a major cause of morbidity and mortality worldwide. The most prevalent etiologies of chronic liver diseases include chronic hepatitis B virus (HBV) infection, chronic hepatitis C virus (HCV) infection, nonalcoholic fatty liver disease (NAFLD), and alcohol abuse [1]. Chronic liver diseases can lead to liver fibrosis, which is the result of chronic liver injury [2]. The end-stage of liver fibrosis is cirrhosis, which haspotential complications including portal hypertension, liver failure, and hepatocellular carcinoma (HCC). There is evidence that when the underlying cause is removed, liver fibrosis may regress or stabilize [3]. Accurate staging of liver fibrosis may be beneficial in monitoring treatment efficacy, disease progression, and in establishing prognosis. Elastography is an imaging technique used to evaluate the mechanical properties of tissue according to the propagation of mechanical waves. MRI or US is coupled with a device that generates mechanical waves, typically shear waves within the tissue (s) of interest. The shear wave velocity is then measured to calculate quantitative results. The shear wave velocity in tissue is directly related to the stiffness of the tissue [4, 5]. Propagation of shear waves is faster in stiff or hard tissues and slower in soft tissues [6]. Although elastography can be used to evaluate the stiffness in many organs, currently it is most commonly used for liver applications [7]. Ultrasound-based elastography is primarily used as an alternative to liver biopsy for the assessment of hepatic fibrosis. It can also be used to predict complications in patients with cirrhosis. Society guidelines on the use of ultrasound elastography of the liver are available [8-11]. In a typical liver MR elastography configuration, an active pneumatic mechanical wave driver is located outside the MR elastography room and is connected, by way of a flexible 25-ft (7.62-m) polyvinyl chloride tube, to a passive driver that is fastened onto the abdominal wall over the liver [12, 13]. The passive driver generates a continuous acoustic vibration that is transmitted through the entire abdomen, including the liver, at a fixed frequency, which is typically 60 Hz [14]. The present study was conducted to compare the ultrasound elastography and MR Elastography for assessing liver fibrosis.

Material and Methods

In the present study 100 patients with diagnosed liver fibrosis were included in the study. Before the commencement of the study ethical approval was taken from the ethical committee of the institute and informed consent was taken from the patient. Patients with accompanying other liver diseases were excluded. The screening process consisted of a standardized clinical evaluation which included a detailed physical examination, biochemical profiling, and an alcohol history. Participants were instructed to fast for at least 8 h prior to ultrasound elastography and MR Elastography exams.

Histologic analysis

The clinically obtained biopsy specimen was reviewed by single person and scored the histologic features using the NASH Clinical Research Network histologic scoring system [15]. Fibrosis was scored from 0 to 4.

SWE exam

SWE exams were performed on a clinical ultrasound system. The ultrasound system was equipped with the transducer and software required for SWE. For SWE, participants were imaged in the dorsal decubitus position with the right arm fully abducted to facilitate a right intercostal approach. The transducer was oriented perpendicular to the liver capsule to optimize the acoustic window. Then, SWE was activated and, once a real-time colorized stiffness map of the right liver parenchyma had stabilized during an 8-10-s breath hold at shallow expiration, the sonographer recorded the stiffness map with a button press. The sonographer then placed a circular ROI at least 1 cm below the liver capsule but no more than 8 cm from the skin surface that overlaid as much of the homogeneous color map as possible while avoiding large blood vessels, portal tracts, and rib shadowing. The mean and standard deviation of shear wave speed values within the ROI were recorded. The above steps were repeated until 10 sequential shear wave speed (SWS) measurements were acquired per participant (out of a maximum of 20 attempts), as recommended by the manufacturer.

MR exam: MRE and chemical-shift-encoded MRI

MR exams were performed using a 1.5 T research scanner with a 60-cm bore and a 12-channel torso radiofrequency coil array. An active acoustic driver set to the standard frequency of 60-Hz delivered vibrations via a passive pneumatic driver that was centered over the liver and secured snugly to the abdominal wall by an elastic band. A two-dimensional (2D) gradient-recalled-echo (GRE) MRE sequence modified with bipolar motion encoding gradients synchronized to the applied vibration imaged the shear wave displacement. Four 10-mm contiguous axial slices were acquired through the widest transverse section of the liver, each with a 16-s breath hold performed at relaxed end-expiration. Acquisition parameters are listed in Supplemental Methods. Using MRE reconstruction software, the MR scanner automatically processed the wave images into cross-sectional 2D shear-stiffness maps.

One of two trained image analysts downloaded the raw and processed MRE data for offline analysis. Using MRE analysis software ("MRE Quant", Resoundant), the analyst manually drew free-form ROIs on portions of the right hepatic lobe on the wave images while avoiding the liver edge (outer 1 cm), major vessels, and areas of non-planar or low amplitude wave propagation. The ROIs were drawn on all four slices and colocalized to the shear-stiffness maps. The mean of liver stiffness in the ROIs (shear stiffness, in kilopascals) and cumulative ROI size over four slices (in pixels) were automatically reported by the software. An MRE exam was considered adequate if the total number of pixels over four slices acquired in a participant was greater than or equal to 700 pixels.

Chemical-shift-encoded MRI acquisition and analysis

A 2D multi-echo spoiled gradient-recalled-echo sequence with magnitude reconstruction was performed through the entire liver. Using a previously described custom algorithm, the MR scanner automatically processed the source images into cross-sectional PDFF maps, which were analyzed offline to calculate mean liver PDFF values. Acquisition and analysis details are described in Supplemental Methods.

Blinding

The pathologist was blinded to imaging data. Sonographers were blinded to clinical, histological, and MRI data. MR analysts were blinded to clinical, histological, and ultrasound data.

The Statistical difference was assessed and statistical significance was assessed at a type I error rate of 0.05.

Results

In the present study on histopathogical examination it was found that in total, 45, 37, 4, 9 and 5 had fibrosis stages 0, 1, 2, 3, and 4 respectively

Table 1: Histopathological characteristics

Histopathological Stages of Liver fibrosis	N
0	45
1	37
2	4
3	9
4	5

Table 2: Diagnostic performance of SWE and MRE at classifying fibrosis stages

Fibrosis stage	Method	Accuracy
0	MRE	0.720
	SWE	0.560
1	MRE	0.850
	SWE	0.530
2	MRE	0.820
	SWE	0.480
3	MRE	0.740
	SWE	0.630
4	MRE	0.740
	SWE	0.630

The Accuracy of MRE was significantly higher than those of SWE for diagnosing any fibrosis.

Discussion

MRE is a technique used to measure the mechanical properties of tissues (such as stiffness, elasticity, and viscosity) by acquiring images of the propagation of a shear wave created by an external source of motion. MRE requires several components to generate mechanical waves, acquire MR images of wave motion, and produce quantitative maps of liver stiffness. Briefly, an external driver is necessary to create the mechanical waves, a phase-

contrast pulse sequence with motion-encoding gradients to encode tissue motion, post processing to track wave length and amplitude, and inversion algorithms to create quantitative maps of tissue stiffness (also known as elasto grams) [16].

The present study on histopathogical examination it was found that in total, 45, 37, 4, 9 and 5 had fibrosis stages 0, 1, 2, 3 and 4 respectively. The Accuracy of MRE was significantly higher than those of SWE for diagnosing any fibrosis.

A previous study by Furlan *et al*. on American adults with NAFLD examined the diagnostic performance of SWE and MRE at detecting significant fibrosis (stage ≥ 2) and advanced fibrosis (stage ≥ 3) and did not find a statistically significant difference [17].

A recent study by Imajo *et al.* on Japanese adults with NAFLD examined the diagnostic performance of SWE and MRE at detecting the full spectrum of fibrosis and found that MRE offered superior performance at staging cirrhosis only [18].

Sabina Wiecek *et al* did a study on Assessment of Liver Fibrosis with the Use of Elastography in Paediatric Patients with Diagnosed Cystic Fibrosis. CFLD was diagnosed in 16 / 41 patients (39%). Abnormal elastography was observed in 19 / 41 patients (46.3%), and in 5 / 41 (12.2%), the changes were advanced (F4). Abnormal elastography was observedin 12 / 16 (75%) of the patients with CFLD, and in 7 / 25 (28%), there were no lesions observed in the liver in the course of cystic fibrosis. In all patients with F4, we observed abnormal results of the APRI and Fibro test. In most patients with small changes in elastography, we found normal results of the APRI and Fibro test [19].

Conclusion

Present study concluded that MR Elastography was better than ultrasound elastography for assessing liver fibrosis

Conflict of Interest

Not available

Financial Support

Not available

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