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ORIGINAL ARTICLE

Comparison of Diagnostic Accuracy of Magnetic Resonance Imaging and Transient Elastography Fibro Scan for Detecting Liver Fibrosis

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ABSTRACT

Objective: Diagnosing liver fibrosis without resorting to invasive surgery is in high demand but underserved. The focus of this study is on the diagnostic accuracy of MRI and the transient elastography fibro scan for liver fibrosis.

Methodology: After the ethical approval from institute review board, sixty patients with liver fibrosis were selected by random sampling technique underwent multiparametric MR, transesophageal echocardiography (TE), and blood testing in this single-center cross-sectional study. Noninvasive treatment alternatives were weighed against histological information including stage and grade (such as MR fat and iron content). The diagnostic accuracy of each method for F3 and F4 hepatic fibrosis, as well as for advanced fibrosis, was evaluated using ROC curve analysis. Each technique was evaluated based on its accuracy (F3–F4).

Results: Magnetic resonance elastography was used to find significant correlations between fibrosis stage and collagen content ($r = 0.66$; $P = 0.001$), as well as between inflammatory grade and collagen content ($r = 0.53$; $P = 0.036$). The MRE, TE, DCE-MRI, DWI, and APRI all had AUCs of 0.78 or above, while the AUC for identifying advanced fibrosis was 0.71. Advanced fibrosis AUC values were between 0.94 and 0.77, 0.79 and 0.79, and 0.70 and 0.70. (F3–F4).

Practical implication: This study will to determine which diagnostic technique is better suited to accurately diagnose the liver fibrosis patients.

Conclusion: The strongest correlation was seen between histological markers and MRI. The ability of magnetic resonance imaging to detect advanced liver fibrosis and cirrhosis was also superior to that of transient elastography fibro scans.

Keywords: MRI, Liver fibrosis, diagnostic accuracy, transient elastography fibro scan

INTRODUCTION

Numerous noninvasive techniques have been developed to reduce the number of individuals who require a liver biopsy, including transient elastography fibro scan, magnetic resonance imaging, and serum indicators. TE has been shown to be effective in detecting fibrosis and cirrhosis in large cohort studies[1-2]. For the first time, magnetic resonance elastography may be utilized to map the stiffness of liver tissue using MRI-based waves [3]. MRE can identify hepatic fibrosis, but the reported data is less than that of the TE. Fibrosis impairs diffusion by altering the molecular diffusion properties of tissues [4].

Using Diffusion Weighted MRI (DWI), it was discovered that these characteristics change throughout time [5]. Within a voxel, incoherent motion occurs. By analyzing perfusion and molecular diffusion separately, researchers hope to enhance the diagnosis of fibrosis and cirrhosis in tissues using DWI [6-7]. Only a few studies have assessed the breadth of noninvasive technologies available for fibrosis detection [1-5].

MRE outperformed DWI in terms of performance, the researchers discovered. Studies discovered a higher sensitivity for detection when using DCE-MRI rather than DWI. Two studies established that TE and shear wave elastography are superior, however a third study indicated no difference[(8-10)]. Numerous multiparametric MRI parameters have never been directly correlated with TE and other blood indicators previously. Diagnosing liver fibrosis without resorting to invasive surgery is in high demand but underserved. The focus of this study is on the diagnostic accuracy of MRI and the transient elastography fibro scan for liver fibrosis.

METHODOLOGY

This cross-sectional study, which will examine just one tertiary care facility in Pakistan, has been given the go light by the hospital's Institutional Review Board. Before any participant participated in the study, they were required to fill out and sign a written consent form. Between October 2020 and June 2021, the health of sixty patients with liver disease was assessed selected by random sampling method diagnosed with liver fibrosis. A total of 60 people were surveyed (20 males and 40 women, ranging in age from 23 to 69). The study was piloted on 12 healthy subjects chosen at random (eight men and four women, ranging in age from 19 to 42 years, with a mean age of 29 years). The team wanted to gauge the potential utility of the methodology for future research. Patients suspected of having cirrhosis were referred to the radiology department for further testing.

Liver fibrosis was seen in the tissues removed during a hepatectomy on patients with hepatocellular carcinoma and cirrhosis. On average, 85 days passed between the two projects' start dates. In this study of 49 people, researchers discovered that persistent HCV infection was linked to an increased risk of developing a variety of liver diseases. All other studies (n = 10) might include patients with eGFRs below 30, though. Participants were required to fast for a minimum of six hours before beginning the trial.

Between October 2020 and May 2021, MRI scans were performed on the subjects using multichannel spine and body coil arrays. The resulting images were 1.5T and 3.0T in magnitude. May and June of 2021 saw clinicians using DCE and IVIM DWI to check in on patients using 1.5T. The MRE equipment installation process used a 3.0T network. In order to lower the amount of distortion contributed to the DWI series, a 1.5T system was used instead of a 3T system (5). Observers may see individuals standing around with their arms raised. Recent research (6) has shown that the variation in quantitative measurement accuracy across platforms is either negligible or equal to the variation in accuracy across scans. Despite the use of a wide variety of channels. Researchers in the field of imaging targeted their efforts at signal modeling on the right areas of the liver (DCE-MRI: GHJ, 2 years postdoc; IVIM/MRE: HAD, 3 years postdoc; fat and iron quantification: OB, 2 years postdoc). At 1.5T, the patient's liver was analyzed to determine the total quantity of fat and iron present. This is the supplementary material, (Appendix 1).

A single-shot echo-planar imaging sequence was used with fat suppression to perform intravoxel incoherent motion DWI on sixty people. The b values were determined by taking samples at 15, 30, and 45 s/mm2. Five-hundred-one people took part in the 3D FLASH DCE-MRI study. T1-weighted dynamic contrast-

enhanced magnetic resonance imaging (DCE-MRI) was performed before and after a gadolinium contrast injection and a saline flush in patients with an estimated GFR of greater than 60 ml/min/1.73 m2 at Bracco Diagnostics. The MRI was also performed on these people. Nine participants were excluded from the DCE-MRI study due to renal insufficiency. To prevent the saturation effects that can come from taking too much Multihance, only half of the recommended amount was given (7). Mechanical waves at 60 Hz were produced by an acoustic driver and applied to the livers of 42 MRE. The xiphoid process was fixed to the right anterior chest wall near the midpoint of that wall.

Rapid gradient echo was used to get 2D MRE images. In March of 2021, just 42 of our university's sixty students were eligible to take the Medical College Admissions Test (MRE). We collected 48 samples for an experiment to put this theory to the test. The operation was performed by three TE operators utilizing a 3.5 MHz probe and 50 Hz transient pulses on the same day as the MRI (FibroScan). Ten precise readings of liver stiffness (in kPa) revealed a difference of less than 30% between the center and the bottom. In total, 54 uses could be found for the serum. On the same day, we performed an MRI, an ELF, and an AST to platelet ratio (8). Unfortunately, there was insufficient blood to test for the six people who declined to donate.

The pathologist looked at the histology to learn more. At least five portal tracts, each measuring 15 mm in length, were needed for liver core needle biopsies and large tissue slices obtained from resection specimens. To perform a routine morphological examination and assessment of steatosis, liver samples were formalin-fixed, paraffin-embedded, and haematoxylin- and eosin-stained. Hemosiderin and fibrosis staining also made use of stains like Perls' Prussian blue and Masson trichrome. Two semi-quantitative scoring systems were utilized to ascertain the fibrosis stage (F0-F4, activity grade A0-A3) and inflammatory levels. The METAVIR and Brunt techniques were used to treat HCV and HBV, respectively (9). The amount of collagen that was found was also calculated.

Statistical Analysis: To assess the relationship between the factors studied and the stages and grades of disease, Spearman's correlations and precise Mann–Whitney tests were performed (for gender, HCV status, and presence of iron or fat). When confounding factors were included in the study, Spearman rank correlation coefficients were utilized to investigate the association between non-invasive and histopathologic examinations. The purpose of this analysis was to determine which noninvasive parameters were most efficient at detecting moderate to advanced and advanced fibrosis, as well as which noninvasive parameter combinations were most effective at detecting these two states concurrently. A weighting factor equal to accuracy (1/n) was applied to account for the increased power provided by larger sample numbers (n). ROC analysis was utilized to analyze single non-invasive readings using this method. The Delong test was used to compare AUCs. AUC of 0.70 was used to determine the sensitivity and specificity of two or more variable combinations. A positive diagnostic of fibrosis was defined as one in which n–1 of n parameters resulted in a favorable outcome.

RESULTS

No activity score was assigned to Stage 4 individuals with cirrhosis who had not completed histological examination (n = 2) (table 1). 22 patients had steatosis, and 11 individuals had iron deposition; none of the patients had iron overload. Collagen in 51 persons might possibly be quantified using a Sirius index ranging from 0.2 to 42.4 percent. 3/60 (5%), and 4/42 (99%) patients, respectively, experienced unsuccessful DWI or MRE surgeries due to iron accumulation in the liver or mechanical MRE system failure. Only 1/51 (or 1.9%) of patients received unsuccessful DCE-MRI. TE was unsuccessful in 2/48 patients due to ascites or obesity (4.1 percent).

Age, body mass index, and scholastic level all lacked a statistically significant correlation (P = 0.39, 0.177, and 0.49, respectively). At the level of the stage, the difference between the sexes was statistically significant (P 0.001), but not at the level of the grade (P = 0.835). Stage (P = 0.24) and grade (P = 0.155) did not differ significantly between individuals with and without HCV. Patients with fat accumulation (P = 0.17/0.95) or iron deposition (P = 0.84/0.1) did not differ significantly in stage or grade. Experiments were conducted with these variables in place to remove the confounding effects of age, gender, BMI, HCV, fat, and iron. The study found that the adoption of non-invasive methods was significantly correlated with reduced fibrosis and inflammation (Table 2).

Researchers discovered a significant link (r = 0.66) between fibrosis and MRE. Only the correlation between liver collagen content and stiffness (r = 0.53; P = 0.036) was found to be statistically significant. It was shown that the presence of collagen in the liver was correlated with the liver's degree of stiffness. Grade had no association with age (P = 0.39), life stage (P = 0.49) or BMI (P = 0.175). Statistically, there was a difference between sexes at the stage level (P = 0.001) but not at the grade level (P = 0.835). Both stage (P = 0.24) and grade (P = 0.155) did not differ significantly between individuals with and without HCV. When comparing patients with and without fat accumulation (P = 0.17/0.95) or iron deposition (P = 0.84/0.1), there was no statistically significant difference in stage or grade. These criteria were used to remove the potentially confounding effects of age, gender, BMI, the hepatitis C virus (HCV), fat, and iron from the tests. The study's findings suggest that the employment of non-invasive methods has substantial relationships with markers of fibrosis and inflammatory severity (Table 2). Our results showed a significant association (r = 0.66) between fibrosis and MRE. Only the correlation between liver collagen content and stiffness (r = 0.53; P = 0.036) was found to be statistically significant. It was shown that the presence of collagen in the liver was correlated with the liver's degree of stiffness.

D diffusion coefficient was one of the best methods to see if the fibrosis was becoming worse (P 0.027). There was no statistically significant difference between MRE and the other methods, as measured by AUC. The majority of the time, there was not an association between ELF and the severity of the disease; however, APRI measurements did tend to rise in patients who had advanced disease. (Table 3)

Table 1:

Parameter	N = 60
Sex (M/F)	40/20
Age (years) BMI (kg/m^2) Aetiology of liver disease (n = 60)	55.2 10 (23–69)–36.8) 26.7 4.4 (18.2
HCV	49 (81.6%)
Non-HCV	11 (18.4%)
Histological activity (METAVIR) A0	 7
A1	20
A2	22
A3	9
Fibrosis score F0	 2
F1	10
F2	21
F3	16
F4	11
Sirius index	10.21 ±9.10% (0.2–42.4%)

Trends were observed in both the actual diffusion coefficient (D) and the MRE liver stiffness, and significant relationships were found between progressive fibrosis and the APRI, the DCE-MRI mean transit time, the TE liver stiffness, and the APRI. This is probable because the study only looked at a small sample size (Table 3). When comparing the effectiveness of MRE, DWI, and DCE-MRI in detecting items, a difference was found that was statistically significant (TTP, P = 0.01). The AUC of the MRE was not significantly different from those of the other modalities (P =

0.062). It was discovered that the ELF played no significant role (P = 0.0134), to put it another way. When comparing F2-F4 and F3-F4 results on the ELF test, the AUC for F2-F4 is 0.61 and the AUC for F3-F4 is 0.63. We combed through a wide variety of imaging datasets seeking robust independent predictors of fibrosis, but came up empty-handed.

Table 2:

		Stage		Grade		Sirius index	
Technique	Parameter measured	Spearmen Correlation	Spearmen Correlation	Spearmen Correlation	P Value	Spearmen Correlation	P Value
DWI DCE-MRI	D Ft MTT	0.29 0.37 0.54	0.072 0.031 0.001	0.32 0.28 0.52	0.041 0.099 0.002	0.10 0.05 0.06	0.627 0.819 0.793
MRE	LS-MRE	0.66	<0.001	0.58	0.002	0.53	0.036
TE	LS-TE	0.58	0.001	0.24	0.200	0.31	0.134
Blood tests	APRI	0.56	0.001	0.41	0.015	0.20	0.310

Table 3:

Technique	Parameter	F0–F1	F2–F4	P Value	AUC	Threshold	Sensitivity	Specificity
DWI	D	1.08±0.16	0.98±0.20	0.158	0.79(0.56-0.93)	<1.00	75 (48–92)	83 (36–100)
MRE	LS-MRE	2.95±0.99	3.99±1.49	0.027	0.78(0.55–0.92)	>3.90	56 (30–80)	100 (54–100)
TE	LS-TE	11.07±10.0	16.29±15.25	0.252	0.82 (0.60–0.95)	>6.8	87 (62–98)	83 (36–100)
DCE-MRI	MTT	13.6±11.9	15.6±8.7	0.567	0.72 (0.48-0.89)	>16.9	44 (20–70)	100 (54–100)
Blood tests	APRI	0.44±0.27	1.12±1.22	0.076	0.70 (0.56–0.82)	>0.48	41 (26–58)	100 (71–100)
		F0–F2	F3–F4	P Value	AUC	Threshold	Sensitivity	Specificity
DWI	D	1.06±0.21	0.94±0.16	0.061	0.79 (0.56–0.93)	<0.92	67 (30–92)	85 (55–98)
MRE	LS-MRE	2.88±0.91	5.16±0.95	0.062	0.94 (0.80–0.99)	>4.07	92 (64–100)	92 (73–99)
TE	LS-TE	9.55 ±6.85	21.44±17.86	0.012	0.77 (0.62–0.89)	>8.6	77 (55–92)	70 (47–87)
DCE-MRI	MTT	11.6±8.1	18.8±9.1	0.01	0.79 (0.65–0.89)	>11.5	80 (59–93)	72 (51–88)
Blood tests	APRI	0.68±0.69	1.32±1.41	0.033	0.71 (0.56–0.83)	>0.84	75 (53–90)	57 (37–75)

DISCUSSION

Adults with chronic liver disease were assessed in this pilot trial using advanced MRI techniques and blood markers to determine whether or not they had fibrosis. Water diffusion is harmed as collagen accumulates, resulting in decreased actual and perceived water diffusion coefficients. Previous research has established that ADC (which comprises diffusion and perfusion components) is a sensitive indication of tissue fibrosis alterations[10]. In the treatment of liver cirrhosis, b-values and ADC are utilized to evaluate tissue perfusion, with promising outcomes[11].

Yoon et al. discovered that pseudodiffusion and ADC were effective methods for detecting fibrosis. This results in parenchymal flow estimates that can be used to detect abnormal hemodynamics in cirrhosis and portal hypertension, respectively. Increased parenchymal resistance to flow and compartmentalization in the fatty liver results in longer tracer transit times. Previous research has connected DCE-MRI characteristics to predictors of advanced liver fibrosis and cirrhosis[13].

We discovered that advanced fibrosis could be recognised with the greatest accuracy when the mean transit time was used. Contrary to earlier research findings, no arterial buffer response was detected at increased fibrosis levels[14]. Due to the increased difficulty of the procedure, DCE (MRI) is the only test that can detect advanced fibrosis in individuals with renal failure. Numerous large-scale studies have examined the viability of transient elastography fibroscan in people for detecting fibrosis and cirrhosis[15]. Our F2–F4 and F3–F4 detection AUCs, on the other hand, were marginally lower than previously reported values. Newly recommended detection thresholds were dropped to 8.6 millibars from 9.9 to 12.9 millibars. At 6.8 kPa, fibrosis was discovered, which is within the previously described F2–F4 range (6.5–8.9 kPa)[14, 15]. The stiffness of the liver measured using TE and MRE is estimated to differ by 2.5–3 times[16].

Prior to this study, the DWI, TE, and MRE were compared [17]. MRE exhibited the highest AUC for advanced fibrosis identification in prior investigations. In comparison to previous research, we discovered a lower AUC for detecting intermediate to advanced fibrosis[18]. We achieved the best detection thresholds for F3–F4 at 4.07 kPa, compared to the industry standard of 3.13–6.47 kPa. These disparities are most likely explained by the fact that MREs are used in a variety of ways across different platforms and that the patients investigated represent a diverse patient population. Patients with chronic HBV and MRE and fibrosis were previously related (r = 0.78) in a study that was sturdier than ours (r = 0.72) [12]. Bear in mind that collagen testing procedures vary, and this is critical to remember. The efficacy of antiviral or antifibrotic medication must first be established by establishing whether or not future stiffness changes are detectable. Magnetic resonance elastography does not require any lengthy or complicated procedures.

MRE may be superior to TE when examining the efficacy of antiviral or antifibrotic medicines due to its high repeatability. Among the several disadvantages of MRE are the demand for MRI platform hardware and software upgrades, which may not be available in all centres, as well as an increased price tag. True diffusion coefficient, mean transit time, and TE/MRE measurements of hepatic stiffness can all be used to detect NASH inflammation. These parameters have been demonstrated to correlate with both the stage of fibrosis and the degree of inflammation[13]. A larger research of inflammation as a possible confounding factor in identifying fibrosis is necessary[19]. For example, iron and fat content can have an effect on quantitative assessments. As a result, fat and iron were treated as distinct factors in the study.

In three instances, the failure of DWI and MRE measurements was attributed to iron deposition. Our conclusions have significant flaws. To begin, the results must be replicated in a second group due to the limited sample size. The sample sizes for the two approaches varied due to changes in failure rates and exclusion criteria. Additionally, the results may be influenced by the MRI machine used. Recent investigations have found that inter-platform variability is comparable to or less than inter-scan variability [20].

CONCLUSION

MRI was found to be the most accurate noninvasive method for detecting advanced fibrosis (F4+) in individuals with chronic liver disease; yet, MRE was found to be as accurate as TE and DWI in diagnosing mild to moderate fibrosis (F2-F4).

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