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ORIGINAL ARTICLE

Analysis of the Role of Shear Wave Elastography in Diagnosing Focal Liver Lesions

SOBAN SHAHID[1], SAHAR JAVED[2], MUSTAFA ALI SIDDIQI[3]
[1]*Consultant Radiologist, Buch International Hospital Multan*
[2]*Senior Registrar, Paediatric Radiology,CH&ICH Multan*
[3]*Associate Professor, Radiology, CPEIC Multan*
Correspondence to: Sahar Javed, Email: drkhan1224@yahoo.com, Cell: +923336156677

ABSTRACT

Objective: Focal hepatic lesions are the second leading cause of death in men worldwide. However, shear wave elastography (SWE) has proved to help assess liver fibrosis. We aim to demonstrate the role of shear wave elastography in the diagnosis of focal liver lesions.

Methods: A prospective study was conducted in the radiology department of CPEIC Multan from April 2021-April 2022. A total of 70 patients with 93 focal lesions were included. Shear wave elastography (SWE) was performed on all the patients, and local lesions and parenchyma stiffness values were calculated. Ten patients were excluded as they failed elastography acquisitions. Contrast-enhanced CT and MRI were performed on the remaining 60 patients.

Thirty-two patients underwent liver biopsy. Benign focal lesions were confirmed by analyzing the results of ultrasound biopsy, CT, and MRI.

Results: Cholangiocarcinoma was found to have the highest stiffness value (34.2kPa), hence the stiffest malignant lesion. Focal nodular hyperplasia had a stiffness value of 25.4kPa and was the most stiff benign lesion. The average stiffness value between malignant and benign lesions had a significant difference, the value of malignant lesions being significantly high ($p<0.001$).

Conclusion: Shear wave elastography can efficiently differentiate between malignant and benign hepatic lesions and can individually characterize these lesions accurately.

Keywords: Focal liver lesions, malignant, stiffness value, shear wave elastography, benign

INTRODUCTION

Hepatic focal lesions are regarded as a significant issue and often harmful but some lesions are cancerous. Liver cancer marks the 2nd major cause of death in males and the 6th major reason of mortality in females globally[(1)]. Focal liver lesions are categorized as benign or malignant hepatic lesions. Benign lesions are either solid or in the form of cysts and can be divided into sub-types, including hemangioma (most commonly occurring), focal fatty change, hydatid cysts, hepatic adenoma, bile duct cysts, and focal nodular hyperplasia[(2)]. On the other hand, malignant lesions can be classified into primary or secondary (caused by treatment of prior tumor) . Hepatocellular carcinoma is the most common primary malignant cancerous tumor, and cholangiocarcinoma comes second as the common neoplasm. Hepatoblastomas and angiosarcomas are rare types of liver cancers[(3)].

Focal liver lesions can be evaluated and diagnosed by both non-invasive methods such as magnetic resonance imaging, positron emission tomography, ultrasound and computed tomography, and through invasive procedures such as percutaneous biopsy and rarely by angiography[(4)].

The most commonly used technique is ultrasound, as it is an inexpensive, can be easily performed, and safest procedure as it is done by employing sound waves and not radiations like most other methods. Computed tomography is also used to diagnose focal liver lesions by using intravenous iodinated contrast media. However, this procedure exposes the patients to high radiations, and the contrast media may not be suitable for people with a history of kidney failure and anaphylactic shock. MRI is a preferable procedure as it does not involve exposure to radiation, and its contrast media can be in patients for whom iodinated media is not suitable. However, MRI is a time consuming and expensive method[(5)].

Among all these methods, liver biopsy is the usually used as a diagnostic gold standard for comparison between benign and malignant liver lesions. Its drawback is that it is an invasive technique that may have adverse consequences such as pain, morbidity, and death risks, and its diagnostic accuracy is limited due to sampling variability[(6, 7)].

Most of the limitations of these procedures is eliminated by ultrasound elastography which is a non-invasive diagnosis and imaging of tissue elasticity distribution by utilizing conventional ultrasound with improved machinery.

Shear wave elastography is an elastography type that is a comparatively easy, non-invasive, and fast technique that has been recently used to demonstrate hepatic elasticity[(8)]. It has more benefits than other techniques, such as high spatial resolution, reproducibility, operator-independent, and can calculate stiffness values automatically. It uses shear waves whose velocity calculates the tissue stiffness. SWE has proved to help assess liver fibrosis and can be used to assess hepatic lesions and their differentiation[(9)]. We aim to demonstrate the function of shear wave elastography in the diagnosis of focal liver lesions.

METHODOLOGY

A prospective study was conducted in the radiology department of CPEIC Multan from April 2021-April 2022. A total of 70 patients with 93 focal hepatic lesions were selected for the study. The patients had single or multiple lesions greater than 1cm, which was diagnosed by any imaging technique. The patients whose lesions were smaller than 1 cm, could not hold their breath for a long time, were pregnant, obese, and had a former history of hepatic focal lesions were excluded from the study. All the patients provided their written consent to be a part of the study.

Among all the patients, the largest hepatic lesion was set as a representative as in Qiang et al. After the analysis; ten patients were excluded due to failure of elastography acquisitions.

Therefore, 60 patients were selected for the final procedure who were older than 18 years but not more than 65 years old (average age= of 50 years).

Shear wave elastography was performed on all patients after an initial ultrasonography examination in a supine position. SWE was targeted at hepatic focal lesions and surrounding hepatic parenchyma to calculate stiffness values. The SWE measurements were obtained and the images were analyzed by two independent physicians.All the procedures were performed by expert radiologists; however, they were blinded to the final results. Patients were required to hold breathe, and the average stiffness value was calculated by three consecutive SWE acquisitions. The build in ROI system classified the lesions as lowest stiffness and highest stiffness with dark blue and dark red color, respectively. A post-contrast triphasic CT was also performed on all patients. CE-MRI was also performed on all patients.

Liver biopsy was performed on 32 patients (31 malignant lesions, one benign hepatic lesions) by obtaining histological tissue samples. Benign focal lesions were confirmed by analyzing the results of ultrasound biopsy, CT, and MRI. If inaccuracy was observed in the results, a liver biopsy was performed (in 1 FNH patient). For diagnosis of malignant hepatic lesions, a biopsy was performed except for HCC, for which recommendation by the American Association Society of Liver Diseases were used as reference.

All the data were analyzed by using SPSS (version 20). Mean and standard deviation was used to describe quantitative data, while frequency and percentage were used to present quantitative data. Diagnostic accuracy was assessed by the ROC curve. The significance of the tests (p-value) was 5%. The values were significant if p was less than 0.05.

RESULTS

The results were recorded for 60 patients ranging from 18 to 65 years old (average age=50 years). The hepatic lesions were divided into benign and malignant lesions. Forty-one patients had malignant hepatic lesions, and 19 had benign focal lesions. All the malignant and benign lesions patients underwent CE-CT and CE-MRI. However, only 32 patients out of 60 underwent liver biopsy (31 malignant and one benign) (Table I).

The median size of malignant lesions was 4.7 (range:1.4-11.6) and of benign lesion was 5.5 (range:1.8-17.0). Most of the patients (35% patients) were hyperechoic. The lesions' echogenicity is shown in Table II.

Color coding of the focal liver lesions through SWE is shown in Table III. A mixed color with red foci was observed in 36 (87.8%) malignant and 5 (26.3%) benign lesions. 40 (66.7%) of the surrounding liver parenchyma in all lesions appeared with a dark blue color. The colour coding of malignant and benign lesions varied significantly (p<0.001).

The stiffness values of benign hepatic lesions were significantly lower than malignant lesions (9.55kPa vs. 19.9kPa). Similarly, the stiffness of the surrounding liver tissue was higher in malignant lesions as compared to benign lesions (6.73 vs. 4.12) (Table IV).

With respect to malignant lesions, most patients were diagnosed with hepatocellular carcinoma (15 patients (25%)) and metastasis (15 patients (25%)). With respect to benign lesions, six patients had hemangioma (10%), and five patients had focal nodular hyperplasia (8.33%) (Table V). Cholangiocarcinoma had the highest stiffness value among malignant lesions, i.e., 34.2kPa for focal lesions and 6.3kPa for liver parenchyma. Focal nodular hyperplasia had a stiffness value of 25.4kPa and was the stiffest benign lesion.

ROC curve for diagnostic accuracy of shear wave elastography had an AUC of 0.799 with 91% accuracy (Table VI).

DISCUSSION

The diagnostic accuracy of shear wave elastography has not been analyzed in any study in Pakistan. The present study demonstrates the function of SWE in the diagnosis of focal liver lesions. The study included 60 patients ranging from 18 to 65 years old. All patients were diagnosed with CE-Ct and MRI, and only 32 patients underwent biopsy.

In the present study, there was a statistical difference between the color-coding of malignant and benign lesions. 36 (87.8%) malignant and 5 (26.3%) benign lesions showed a mixed color with red foci. 40 (66.7%) of the surrounding liver parenchyma in all lesions appeared with a dark blue color. These results were consistent with Guibal et al.[10] and Park et al.,[11] which showed that high stiffness was indicated by red color and low stiffness was indicated by dark blue.

In Guibal et al.,[10] the FNH was the most stiff benign lesion with a stiffness value of 33±14kPa, while in the present study, the stiffness value of FNH was 25.4kPa. Similarly, the FNH value of hemangioma in our study was 9.4kPa which complies with the stiffness value in Guibal et al., i.e., 13.8 ± 5.5. The stiffness value of 2 cases of abscess in our study was 11.92kPa, and the value of liver parenchyma was 4.73kPa. These values are consistent with Park et al.[11] in which the stiffness value of abscess was 22.13 ± 5.14, and liver parenchyma was 5.77 ± 1.25.

Cholangiocarcinoma had the highest stiffness value among malignant lesions, i.e., 34.2kPa for focal lesions and 6.3kPa for liver parenchyma. The same results were shown in Guibal et al.,[10] Gerber et al.,[12] Sirica et al.,[13] Okamoto et al.,[14] and Heide et al[15].

In our study, the ROC curve for accuracy of SWE in differentiating benign and malignant lesions had an AUC of 0.799 with 91% accuracy, the cut-off value of 14.043, and specificity and sensitivity of 77.4% and 97.4%, respectively. But in Park et al.,[11] the specificity and sensitivity

were 82.4% and 70.6%, respectively, with a cut-off value 30.8kPa. The difference in results may be due to the small sample size as our study only included only 60 patients in comparison with 193 patients in Park et al.

Limitation of the study: Our study had a small sample size. We did not include some lesions such as adenoma and focal fatty sparing and did not include significant number of some important lesions such as abscess, cholangiocarcinoma, and focal nodular hyperplasia.

CONCLUSION

Shear wave elastography can efficiently differentiate between malignant and benign hepatic lesions and can individually characterize these lesions accurately.

Table 1: Focal hepatic lesions diagnosis

Diagnostic methods	Total patients (n=60)	Malignant lesions (n=41)	Benign lesions (n=19)
Biopsy			
Yes	32 (53.4%)	31 (75.7%)	1 (5.3%)
No	28 (46.7%)	10 (24.3%)	18 (94.7%)
CE-CT			
Yes	60 (100%)	41 (100%)	19 (100%)
No	0 (0%)	0 (0%)	0 (0%)
CE-MRI			
Yes	60 (100%)	41 (100%)	19 (100%)
No	0 (0%)	0 (0%)	0 (0%)

Table 2: Lesion characteristics

Characteristics	Total (n=60)	Malignant hepatic lesions (n=41)	Benign hepatic lesions (n=19)	P value
Median lesion size (min-max)	5.4 (1.7-17.03)	4.7 (1.4-11.6)	5.5 (1.8-17.0)	0.198
Lesion boundary				0.895
Well defined	44 (73.3%)	31 (75.6%)	14(74.7%)	
Ill-defined	16 (25.7%)	11 (26.8%)	5 (26.3%)	
Lesion echogenicity				<0.001
Isoechoic	7 (11.7%)	7 (17%)	0 (0%)	
Heterogenous	9 (15%)	8 (19.5%)	1 (5.3%)	
Hyperechoic	21 (35%)	14 (34.2%)	7 (37%)	
Hypoechoic	19 (31.7%)	12 (29.3%)	7 (37%)	
Anechoic	3 (5%)	0 (0%)	3 (15.8%)	
Ascites	9(15%)	9 (21%)	0 (0%)	0.009

Table 3: Color characteristics of hepatic focal lesions

Color	Total (n=60)	Malignant hepatic lesions (n=41)	Benign hepatic lesions (n=19)	P value
Focal lesions				
Yellow green	8 (13.3%)	5 (12.2%)	3 (15.8%)	<0.001
Faint blue	9 (15%)	-	9 (47.4%)	
Mixed with red foci	41 (68.3%)	36 (87.8%)	5 (26.3%)	
Colorless	1 (1.7%)	-	1 (5.3%)	
Parenchymal				
Yellow-green	6 (10%)	6 (14.6%)	-	0.001
Faint blue	10 (16.7%)	10 (24.4%)	-	
Dark blue	40 (66.7%)	21 (51.2%)	19 (100%)	
Mixed	4 (6.7%)	4 (9.7%)	-	

Table 4: Stiffness values of benign and malignant lesions, liver parenchyma

Variables	Malignant hepatic lesions (n=41)	Benign hepatic lesions (n=19)	P-value
Median stiffness of hepatic lesions	19.19 (13.59-36.65)	9.55 (0.0-26.43)	<0.001
Parenchyma median stiffness	6.73 (3.35-17.19)	4.12 (3.45-6.17)	0.001
Lesion/parenchymal ratio	1.53 (0.55-4.36)	1.23 (0.0-3.79)	0.266

Table 5: Shear wave elastography stiffness value

Variables	N	Median stiffness value		Lesion/parenchymal stiffness ratio	P-value
		Focal lesions	Liver parenchyma		
All lesions	60	17.73(0.0-36.65)	5.56(3.37-17.13)		<0.001
Malignant lesions	41	19.98(13.35-36.43)	6.54(3.49-17.13)	1.58(0.55-4.30)	<0.001
Hepatocellular carcinoma	15 (25%)	16.4(14.1-19.08)	12.1 (8.2-17.13)	0.55(0.43-1.43)	<0.001
Metastasis	15 (25%)	24.7 (19.6-27.6)	4.1(3.5-12.2)	3.1(1.4-4.6)	<0.001
Lymphoma	6 (10%)	13.6(13.73-13.7)	4.3(3.4-8.3)	1.7(0.2-1.4)	0.003
Cholangiocarcinoma	4 (6.67%)	34.2(34.5-36.1)	6.3(6.1-11.4)	3.8(1.9-3.21)	0.019
Benign lesions	19	9.54(0.0-26.69)	4.83(3.51-6.01)	1.52(0.55-4.32)	<0.001
Hermangioma	6 (10%)	9.4(8.87-10.03)	4.96(3.3-6.02)	0.88(0.8-1.23)	0.003
Focal nodular hyperplasia	5 (8.33%)	25.4(24.4-26.3)	6.53(4.60-5.92)	3.07(2.8-3.72)	0.007
Simple cyst	1 (1.67%)	0.00(0.00-0.00)	5.02(4.2-5.76)	0.00(0.00-0.00)	0.100
Hydatid cyst	2 (3.33%)	7.79(7.4-12.64)	4.99(3.21-5.43)	1.03(0.8-1.33)	0.04
Fatty infiltration	3 (5%)	9.2(7.33-10.12)	4.32(3.1-5.30)	1.62(0.8-1.04)	0.019
Abcess	2 (3.33%)	11.92(11.3-11.2)	4.73(4.72-5.38)	1.18(1.1-1.17)	0.04

Table 6: Differentiation of benign from malignant hepatic lesions based on ROC

AUC	95% CI	P-value	Cut-off	Sensitivity	Specificity	PPV	NPV	Accuracy
0.799	0.68-0.95	<0.001	14.043	97.4%	77.4%	90.2	93.8	91%

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