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Role of ultrasound elastography in the evaluation of focal liver lesions and correlation with HPE

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Abstract

Background: Ultrasound Elastography is a new imaging technique developed to non-invasive assessment of mechanical properties of the lesion. Focal liver lesions are cystic masses seen in the abnormal part of the liver. Ultrasound Elastography is non-invasive, non-contrast enhanced, easy to perform and is efficient in the characterization of focal liver lesion. This study was designed to evaluate and characterize the focal liver lesions by ultrasound Elastography.

Materials and methods: A total of 100 cases with focal lesions referred for image-guided biopsy or planned for surgical resection, between age group 25-70 years were recruited. Cases with multiple lesions, the larger lesion was considered for index lesion. Liver stiffness was measured in the peripheral area of bigger lesion and in the liver greater than 2 cm from the lesion periphery. Data of stiffness value, stiffness ratio and shear wave velocity (m/s) were recorded 5 times for each group.

Results: The mean values of elastographic parameters between malignant and benign FLL show statistically significant difference in stiffness ratio, shear wave velocity, stiffness value and strain ratio ($P<0.05$). The cut-off value of 15.98 for stiffness value with sensitivity 83.3% and specificity 84.5%. The cut-off value for stiffness ratio was 1.68 with sensitivity 70.23% and specificity 67.78%.

Conclusion: The mean values of elastographic parameters were significantly higher in malignant lesions than benign lesions. Strain ration found to be recommended parameter to differentiate focal liver lesions. Ultrasound Elastography is a novel imaging technique which is quick imaging and non–contrast-enhanced method.

Keywords: Ultrasound Elastography, Focal Liver lesion (FLL), Stiffness ratio, Shear wave velocity

Introduction

Focal liver lesions (FLL) are the leading cause of death, globally [1]. Staging and early characterization of focal liver lesions are necessary to formulate optimal treatment methods to get better outcomes [2]. Various contrast enhanced diagnostic modalities like CT and MRI need contrast agents, which require time, cost and leads to allergic reactions. Ultrasound is a leading method in the examination of FLLs, due to easy to use, low cost and minimal radiation exposure. USG is a highly sensitive and specific technique in the evaluation and differentiation of these lesions [3, 4]. Elastography is Ultrasonographic techniques which furnish a non-invasive evaluation of tissue stiffness through the assessment of fine changes across the entire organ [5]. Ultrasound Elastography is a non-invasive method for the determination of tissue stiffness and the measurement value is usually altered by a particular pathological or physiological process of soft tissue [6]. Ultrasound Elastography in the evaluation and characterization of focal liver lesions by stiffness quantification has least literature coverage. This study was designed to evaluate and characterize the focal liver lesions by ultrasound Elastography.

Materials and Methods

The present prospective study was conducted in the Department of Radio-diagnosis, Apollo institute of medical sciences and research, Hyderabad from April 2018 to December 2019. A total of 100 cases with focal lesions referred for image-guided biopsy or planned for surgical resection, between age group 25-70 years were recruited. Cases with focal liver lesions diagnosed by Conventional CT or MRI or USG and cases willing to participate were included. Cases with hepatic cysts, history of treatment for focal liver lesions, females with pregnancy and in the lactating period were excluded. It was important to ensure that informed consent was obtained and that the patients were aware of research and participation was voluntary. They were told that the information obtained would be only for the purpose of research. Confidentiality of patient data was maintained during research. The research proposal was approved by the institutional ethics committee. Cases with focal liver lesions undergone to abdominal sonographic examination and Elastography by Philips affiniti 70 ultrasound machine. Shear wave Elastography was performed by maintaining supine position, with an abducted arm to make right hypochondrium accessible. Cases with multiple lesions, larger lesion was considered for index lesion. Liver stiffness was measured in the peripheral area of the bigger lesion and in the liver greater than 2 cm from the lesion periphery. Data of stiffness value, stiffness ratio and shear wave velocity (m/s) were recorded 5 times for each group. Strain Elastography image box was fixed completely over the lesion and probe applied with vertical pressure, avoiding lateral movement. Strain values of tissues were measure by regions of interest in the lesion and strain ratio values were measured. The obtained results were correlated with histopathological findings and differentiation between benign and malignant focal liver lesions was assessed. Statistical analysis was done by using SPSS version 20. The Receiver Operator Characteristic (ROC) curve analysis was used to find the Sensitivity, Specificity.

Results

A total of 100 cases with focal lesions referred for image-guided biopsy or planned for surgical resection, between age group 25-70 years were recruited. Majority cases with benign lesions belonged to age group 41-50 years (67%) and with malignant lesions were belonged to age group 55-70 years (59%). Among the cases, 80 cases had a malignant type of lesion and 20 had benign type FLL.

Table 1: Distribution of focal liver lesions.

Lesion type	Total cases (n=100)	
	Number	**Percentage (%)**
Malignant lesions (n=80)		
HCC	22	27.5%
Metastasis	48	60%
Cholangiocarcinoma	10	12.5%
Benign lesions (n=20)		
FNH	07	35%
Hemangioma	13	65%

Table 2: Ultrasonography findings of focal liver lesions.

Type of lesion	Multiplicity		Background		Echogenicity			Vascularity	
	Single	**Multiple**	**Normal**	**Cirrhosis**	**Hetero**	**Hyper**	**Hypo**	**Normal**	**Raised**
HCC (n=22)	17 (77.2%)	5 (22.7%)	07 (31.8%)	15 (68.1%)	14 (63.6%)	01 (4.5%)	07 (31.8%)	08 (36.3%)	14 (63.6%)
Metastasis (n=48)	-	48 (100%)	48 (100%)	-	48 (100%)	-	-	48 (100%)	-
Cholangiocarcinoma (n=10)	10 (100%)	-	10 (100%)	-	10 (100%)	-	-	10 (100%)	-
FNH (n=7)	7 (100%)	-	7 (100%)	-	-	-	7 (100%)	7 (100%)	-
Hemangioma(n=13)	10 (76.9%)	3 (23.07%)	13 (100%)	-	-	13 (100%)	-	10 (76.9%)	3 (23.07%)

Table 3: Statistical difference in elastographic parameters between malignant and benign focal liver lesion.

Elastographic parameters	Malignant lesions (n=80)		Benign lesions (n=20)		p value
	Mean±SD	**Std. Error Mean**	**Mean±SD**	**Std. Error Mean**	
Stiffness value	36.28±11.64	2.981	15.32±5.44	1.633	0.015
Stiffness ratio	3.49±1.67	1.018	1.68±1.56	0.431	0.042
SWV	2.82±0.84	0.152	1.61±0.88	0.387	0.005
Strain ratio	3.87±1.21	0.242	1.324±0.45	0.213	0.024

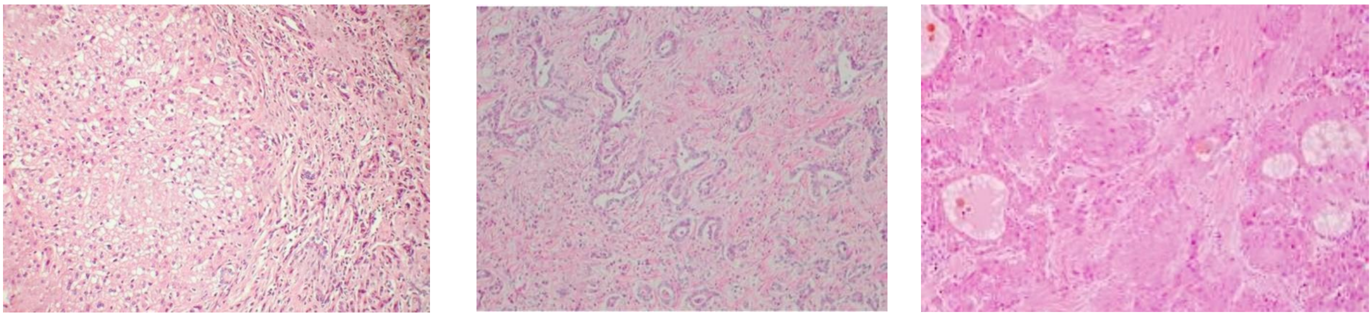
Table 4: Mean stiffness value and shear wave velocity of focal liver lesions and background liver.

Type of lesion	Stiffness value			Shear wave velocity		P value
	FLL	**Background liver**	**P value**	**FLL**	**Background liver**	
Malignant lesions (n=80)						
HCC	36.42	31.12	0.632	2.38	2.61	0.428
Metastasis	28.64	9.47	0.013	2.53	2.24	0.014
Cholangiocarcinoma	38.81	9.25	0.422	2.47	2.48	0.383
Benign lesions (n=20)						
FNH	10.06	6.78	0.545	2.18	2.01	0.316
Hemangioma	12.63	9.33	0.003	1.89	1.59	0.014

Table 5: Details of ROC curve analysis.

Elastographic parameters	ROC curve analysis		
	Cutoff value	**Sensitivity**	**Specificity**
Stiffness value	15.98	82.3%	84.5%
Stiffness ratio	1.68	70.23%	67.78%
Shear wave velocity	1.89	83.21%	82.27%
Strain ratio	2.54	100%	99.9%

Fig 1: USG images of shear wave Elastography, background liver and strain Elastography of focal liver lesions.



A. Cholangiocarcinoma B. Focal nodular hyperplasia C. Hepatocellular carcinoma

Fig 2: Histopathological images of benign and malignant focal liver lesions.

Discussion

Ultrasonographic devices built sono-elastography choice enable the more accurate imaging and evaluation of the nature of superficial focal lesions of many organs in the body. Ultrasound Elastography in the evaluation and characterization of focal liver lesions by stiffness quantification has least literature coverage. This study was designed to evaluate and characterize the focal liver lesions by ultrasound Elastography. A total of 100 cases with focal lesions referred for image-guided biopsy or planned for surgical resection; between age group 25-70 years were recruited. Majority cases had malignant type (80%) of lesion than benign type (20%). Among 80 cases which were found to be malignant, 27.5% were hepatocellular carcinoma (HCC) type, 60% were Metastasis type and 12.5% were Cholangiocarcinoma type (Table 1).

In this study, the mean values of elastographic parameters between malignant and benign FLL show statistically significant difference in stiffness ratio, shear wave velocity, stiffness value and strain ratio ($P<0.05$) (Table 2). A study by Qiang Lu *et al.*, found that the mean stiffness values in cases with hemangioma was 9.3, focal nodular hyperplasia was 10, cirrhotic nodules was 11, HCC was 34, Cholangiocarcinoma was 25 and metastasis was 30 [7]. In this study, the mean stiffness value in cases with hemangioma was 12.63, focal nodular hyperplasia (FNH) was 10.06, HCC was 36.42, Cholangiocarcinoma was 38.81 and metastasis was 28.64. The shear wave velocity in cases with hemangioma was 1.89, focal nodular hyperplasia was 2.01, HCC was 2.38, Cholangiocarcinoma was 2.47 and metastasis was 2.53 (Table 4). A study by Qiang Lu *et al.*, stated that malignant tumour ($p<0.001$) had significantly higher stiffness values and stiffness ratio than benign lesions ($p<0.001$) [7]. A study by Nagarajan KB *et al.*, found that the mean difference between stiffness value, stiffness ratio, shear wave velocity and strain ration was highly significant between malignant and benign lesions [8].

In this study, the cut-off value of 15.98 for stiffness value with sensitivity 83.3% and specificity 84.5%. The cut-off value for stiffness ratio was 1.68 with sensitivity 70.23% and specificity 67.78%. A study by Qiang Lu *et al.*, noticed cut-off value >13 for stiffness value with sensitivity 78% and specificity 83%, positive predictive value 94% and negative predictive value 52% and the cut-off value >1.3 for stiffness ratio with sensitivity 79% and specificity 45%, positive predictive value 83% and negative predictive value 38% [7]. Study by Nagarajan KB *et al.*, had cut-off value 16.5 for stiffness value with sensitivity 79.50% and specificity 81.80% and cut-off value 1.75 for stiffness ratio with sensitivity 66.70% and specificity 63.60%. The shear wave velocity had cut-off value 1.95m/s with sensitivity 82.10% and specificity 81.80%. The strain ratio had cut-off value 2.3 with sensitivity 100% and specificity 100% [8]. A study by Yu *et al.*, found significant difference in the stiffness value between malignant and benign lesions with sensitivity 68% and specificity 69% [9]. Harshavardhan Nagolu *et al.*, in their study with ARFI 2D images, stated that malignant lesions were predominantly stiffer and larger, whereas benign lesions are softer and regular in size. The mean SWVs in benign, malignant, and metastatic lesions were 1.30 ± 0.35 m/s, 2.93 ± 0.75 m/s, and 2.77 ± 0.90 m/s, respectively [9]. A study by Yongqing Wang *et al.*, found that the ultrasound Elastography has sensitivity (76.36%), specificity (80.95%) and accuracy (78.35%) for the malignant focal liver lesions [10].

Conclusion

The mean values of elastographic parameters were significantly higher in malignant lesions than benign lesions. Strain ration found to be recommended parameter to differentiate focal liver lesions. Ultrasound Elastography is a novel imaging technique which is quick imaging and non–contrast-enhanced method. Elastography can be incorporated onto a conventional ultrasound machine, which allows the combination, in one exam, of quantitative Elastography assessment of the liver tumour after the morphological ultrasound examination of the liver and thus paving way to a better and more targeted approach and management.

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