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Radiology

EFFICACY OF ULTRASOUND ELASTOGRAPHY IN CHARACTERIZING FOCAL LIVER LESIONS WITH HISTOPATHOLOGIC CORRELATION

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ABSTRACT

CONTEXT: Elastography, or elasticity imaging, measures the natural tendency of tissue to resume its original size and shape after being subjected to a deforming force or stress [1,2,3]. Neoplastic and inflammatory diseases can change the tissue's composition/structure and thus parenchyma stiffness of an organ. The stiffness measurements can be considered as a method of assessing focal liver lesions and the differentiation of those that are malignant from those that are benign.

AIM: The purpose of the study is to assess whether ultrasound elastography can be used to differentiate between benign and malignant focal liver lesions.

METHODS AND MATERIAL: This prospective study was carried in Rajiv Gandhi Government General Hospital for a period of 1 year. Patients were screened as per inclusion and exclusion criteria. A total of 50 patients with focal liver lesions underwent abdominal sonographic examinations and free hand elastography using Hitachi Aloka Arietta S70 Machine. Elastographic parameters were measured for each focal hepatic lesion. The mean of the observed values was calculated for each group of lesions. These values were correlated with histopathological results. The ability of these values to differentiate between benign and malignant focal liver lesions was assessed.

STATISTICAL ANALYSIS USED: The collected data were analysed with IBM.SPSS statistics software 23.0 Version.

RESULTS: There was highly significant difference between mean values of all four elastographic parameters (**Stiffness value, Stiffness Ratio, Shear wave velocity & Strain Ratio**) between malignant and benign liver lesions (P value $\leq$ 0.01). The mean values of elastographic parameters were significantly higher in malignant liver lesions compared to benign liver lesions. Strain Ratio was found to be a better parameter than the remaining three parameters helpful in differentiating between malignant and benign liver lesions with 100% sensitivity and 100% specificity.

CONCLUSION: Our study showed the feasibility of ultrasound elastography, in discriminating between malignant and benign liver lesions, which can be an aid in further management.

KEYWORDS : Focal Liver Lesions, Shear Wave Elastography, Strain Elastography, Stiffness Value, Stiffness Ratio, Strain Ratio, Ultrasound.

INTRODUCTION:

Characterizing focal liver lesions (FLL) comprises a significant component of health care costs with substantial impact on patient management both in health and disease. It is important to consider not only malignant liver lesions, but also benign liver lesions in the differential diagnosis. Conventional ultrasonography (US) is often the first imaging modality performed to study hepatic lesions because of its low cost and wide availability.

Colour-Doppler, Contrast Enhanced Ultrasound (CEUS) have significantly improved the characterization of Focal liver lesions. Computed Tomography (with or without contrast) and Magnetic Resonance Imaging (with or without) are second line imaging methods able to accurately characterize previously detected lesions, but they are more expensive and less available. Nevertheless, percutaneous biopsy is required to make a definite diagnosis, which is invasive[4].

Ultrasound elastography is an easily applicable, non–contrast-enhanced, non-invasive and fast imaging method that can be performed during the primary sonographic examination of the patient [5,6,7]. This study aimed at prospectively evaluating if ultrasound elastography could be an additional useful tool in the characterisation of focal liver lesions, thereby aiding in further management.

AIM AND OBJECTIVES:

- To acquire ultrasound elastographic parameters (Stiffness value, Stiffness Ratio, Shear wave velocity & Strain Ratio) in persons with focal liver lesions.
- To study the differences among the elastographic parameters obtained from various focal liver lesions and to correlate with the histopathological results.
- To find out the sensitivity and specificity of the elastographic parameters that can be used to differentiate malignant tumours from other benign tumours of the liver.

SUBJECTS:

Patients with focal liver lesions referred for image guided biopsy/ planned for surgical resection were included in this study during the period of 1 year. The patients were selected by the following inclusion & exclusion criteria.

INCLUSION CRITERIA:

- Age between 20 and 80 years, both sexes.
- The presence of focal liver lesions identified by USG / Conventional CT/MRI.

Exclusion Criteria:

- Patients with focal liver lesions which have been treated previously.
- Patients with gross ascites.
- Patients with simple hepatic cysts.
- Uncooperative patients / patients unable to hold breath.

MATERIALS AND METHODS:

Patients with focal liver lesions underwent abdominal sonographic examination and elastography using 3.5MHz convex probe in Hitachi Aloka Arietta S70 machine.

Shear Wave Elastography (SWE) (Fig.1)

- Patients in the supine position & the probe was placed parallel to the intercostal space within the space with sufficient gel in order to minimize rib shadowing.
- The size of the region of interest (ROI) was approximately 1.0 cm by 1.5 cm at a depth of 4 cm. The maximum penetration depth was 7 cm.
- The liver stiffness measurement was performed in areas without blood vessels during a 5-second breath hold at inspiration.
- For patients with multiple lesions, the largest lesion was chosen as the index lesion.
- Liver stiffness was measured in two locations: in the peripheral area of the largest lesion, in the liver at greater than 2 cm from the lesion periphery (background liver).
- From which, stiffness value (kPa), stiffness ratio and shear wave velocity(m/s) were obtained. The measurements were performed

five times for each group.

- The mean value of five measurements for each individual was used in the statistical analysis.

Strain Elastography (SE) (Fig.2)

- After fitting the strain elastographic image box to fully cover the lesion in the liver, we applied the probe with vertical pressure, avoiding lateral movement.
- Strain values of tissues were measured by putting equal or near-equal sized regions of interest (ROI) in the lesion and liver parenchyma.
- Regions of interest were intended to be at the same level as possible to perform the measurements.
- The strain ratio value was obtained which represents the ratio of the strain of focal solid liver lesions to that of normal liver parenchyma.
- Histopathology reports were obtained from the pathology department and the results were correlated with the elastographic parameters.

RESULTS:

Out of the 50 focal liver lesions among the study group, 39 were malignant (78%), 11 were benign (22%) lesions. Out of the 39 lesions which were found to be malignant, 21 were metastases (53.8%), 15 were HCC (38.5%) and 3 were cholangiocarcinoma (7.7%).

And among the benign lesions, 9 were haemangiomas (81.8%) and 2 were FNH (18.2%).

The comparison among the elastographic parameters among various malignant and benign liver lesions (Table. 2&3) showed the below results.

1. There was highly significant difference between mean values of all four elastographic parameters (Stiffness value, Stiffness Ratio, Shear wave velocity & Strain Ratio) between malignant and benign liver lesions (P value ≤ 0.01).
2. The mean values of elastographic parameters were significantly higher in malignant liver lesions compared to benign liver lesions.
3. The Receiver Operator Characteristic (ROC) curve analysis of the elastographic parameters showed the following cut off values in discriminating malignant and benign liver lesions.

a. 16.5kPa for Stiffness value with sensitivity of 79.50% and specificity of 81.80%.
b. 1.75 for Stiffness Ratio with sensitivity of 66.70% and specificity of 63.60%.
c. 1.95 m/s for Shear wave velocity with sensitivity of 82.10% and specificity of 81.80%.
d. 2.3 for Strain Ratio with sensitivity of 100% and specificity of 100%.

Strain Ratio was found to be a better parameter than the remaining three parameters helpful in differentiating between malignant and benign liver lesions.

CONCLUSION:

Ultrasound elastography is a non-invasive, quantifiable, and feasible technique which allows the quantitative assessment of mechanical properties of the lesion. In this recent era concerned with increased interest in active surveillance, further larger prospective studies with a stronger level of evidence are required to assess the potential role of this technique in discriminating the benign vs malignant nature of lesions and among different lesions. To conclude, elastography can be incorporated onto a conventional ultrasound machine, which allows the combination of quantitative assessment and morphological assessment of the focal liver lesions, in one exam and thus paving way to a better and more targeted approach and management.

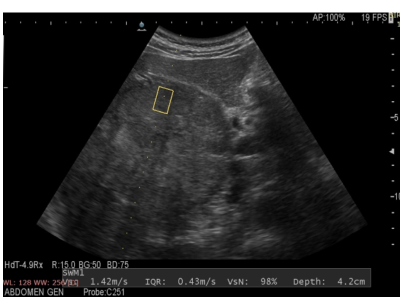


Fig.1. Shear wave elastography (SWE) technique.

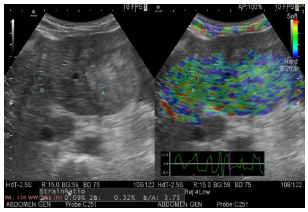
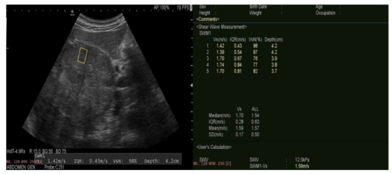


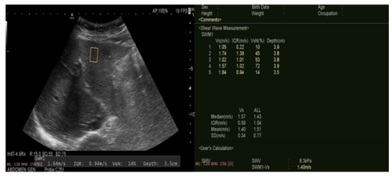
Fig.2. Strain Elastography (SE) technique.

REPRESENTATIVE CASE:

35-year-old female with upper abdominal pain diagnosed to have focal liver lesions on USG. Histopathology showed haemangioma



LESION



BACKGROUND LIVER

Fig.3. (A) & (B) Shear wave elastography in a focal liver lesion & in background liver.

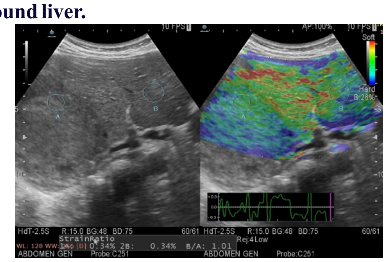


Fig.4. Strain Elastography of the same lesion.

Haemangioma	
Parameter	**Values**
Stiffness of lesion (kPa)	12.00
Stiffness Value of background liver (kPa)	8.30
Stiffness Ratio	1.44
Shear wave velocity of lesion (m/s)	1.59
Shear wave velocity of background liver (m/s)	1.40
Strain Ratio	1.01

Table.1. Elastographic parameters of the same focal liver lesion.

MEAN VALUES OF ELASTOGRAPHIC PARAMETERS BETWEEN MALIGNANT AND BENIGN FLL

Group Statistics

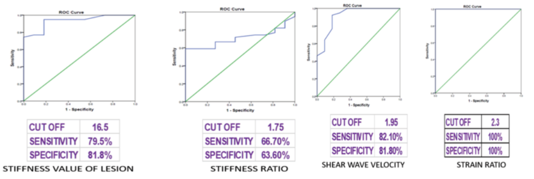
		N	Mean	Std. Deviation	Std. Error Mean
STIFFNESS VALUE OF LESION(kPa)	Malignancy	39	32.51	17.149	2.746
	Benign	11	11.00	4.817	1.452
STIFFNESS RATIO	Malignancy	39	3.595	2.7614	.4422
	Benign	11	1.539	.5547	.1672
SWV OF LESION	Malignancy	39	2.456	.5056	.0810
	Benign	11	1.536	.4478	.1350
STRAIN RATIO	Malignancy	39	3.3644	.52738	.08445
	Benign	11	1.1155	.35024	.10560

Table.2. Mean values of elastographic parameters between malignant and benign liver lesions.

PARAMETER	t value	Sig.P-value
STIFFNESS VALUE	6.925	.0005
STIFFNESS RATIO	4.348	.0005
SWV	5.454	.0005
STRAIN RATIO	13.289	.0005

Table.3. Statistical difference among elastographic parameters between malignant and benign liver lesions.

ROC CURVE ANALYSIS (MALIGNANT vs BENIGN LIVER LESIONS)



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