

DIAGNOSTIC ACCURACY OF STRAIN ELASTOGRAPHY FOR DIFFERENTIATION OF BENIGN AND MALIGNANT HEPATIC LESIONS KEEPING CT AS GOLD STANDARD

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Abstract

Objective:

To determine the diagnostic accuracy of strain elastography in differentiating benign and malignant focal hepatic lesions, using computed tomography (CT) as the gold standard.

Methodology:

This cross-sectional diagnostic accuracy study was conducted in the radiology department of Pakistan Institute of Medical Science Islamabad. A total of 110 patients with suspected focal hepatic lesions who underwent both strain elastography and contrast-enhanced CT scan were included using a non-probability consecutive sampling technique. Patients with previous liver surgery, severe coagulopathy, or those who did not undergo CT imaging were excluded. Strain elastography was performed using a high-resolution ultrasound machine to assess tissue stiffness and calculate strain ratios for lesion characterization. CT scan findings were interpreted independently by radiologists who were blinded to elastography results and were considered the gold standard. Diagnostic performance parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated using statistical software.

Results:

The mean age of the participants was 45.8 ± 13.6 years (range 20–70 years), with 68 (61.8%) males and 42 (38.2%) females. CT scan confirmed 62 (56.4%) malignant lesions and 48 (43.6%) benign lesions. Strain elastography classified 65 lesions as malignant and 45 as benign. When compared with CT findings, 56 cases were true positives, 39 true negatives, 9 false positives, and 6 false negatives. The sensitivity of strain elastography was 90.3%, specificity 81.3%, PPV 86.2%, NPV 86.7%, and overall diagnostic accuracy 86.4%.

Conclusion:

Strain elastography is a useful non-invasive imaging technique for differentiating benign and malignant hepatic lesions. However, CT remains the reference standard for definitive diagnosis and detailed lesion characterization.

INTRODUCTION

Focal hepatic lesions are commonly encountered in clinical practice and encompass a wide spectrum of benign and malignant pathologies. Accurate differentiation between these lesions is essential for determining appropriate management strategies, prognosis, and the need for further intervention (1). Conventional imaging modalities such as ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) are routinely used for the evaluation of liver lesions. Among these, contrast-enhanced CT is widely regarded as a reliable and commonly used reference standard due to its high spatial resolution and ability to characterize lesion vascularity (2,3).

Despite its diagnostic utility, CT has certain limitations, including exposure to ionizing radiation, the use of iodinated contrast agents, and reduced accessibility in resource-limited settings (4). These drawbacks have led to increasing interest in non-invasive, radiation-free imaging techniques that can provide additional diagnostic information.

Strain elastography is an emerging ultrasound-based imaging modality that evaluates tissue stiffness by measuring deformation in response to external compression. Since malignant lesions are generally stiffer than benign ones due to increased cellularity, fibrosis, and desmoplastic reactions, elastography offers a promising adjunct tool for lesion characterization (5,6). In recent years, strain elastography has been increasingly applied in the assessment of liver lesions, demonstrating potential in differentiating benign from malignant focal hepatic lesions (7).

The advantages of strain elastography include its non-invasive nature, real-time assessment, lack of radiation exposure, and relatively low cost. It can be easily integrated into routine ultrasonographic examinations, making it particularly useful in settings where advanced imaging modalities are not readily available (8). However, the technique is operator-dependent and may be influenced by factors such as lesion depth, patient body habitus, and background liver parenchyma, including cirrhosis or fibrosis (9).

Given these considerations, there is a growing need to evaluate the diagnostic accuracy of strain elastography in comparison with established imaging modalities such as CT. This study aims to assess the effectiveness of strain elastography in differentiating benign and malignant hepatic lesions, using CT as the gold standard. Establishing its diagnostic performance could support its role as a valuable adjunct or alternative imaging tool in clinical practice (10).

METHODOLOGY

This cross-sectional diagnostic accuracy study was carried out in the radiology department of Pakistan Institute of Medical Sciences, Islamabad, over 6 months study period. Patients who presented with suspected focal hepatic lesions and underwent both strain elastography and CT scan were included in the study. A non-probability consecutive sampling technique was used to recruit participants who met the inclusion criteria. Patients with a history of previous liver surgery, severe coagulopathy, or those who did not undergo CT imaging were excluded from the study.

Data were collected after obtaining informed consent from all participants. Strain elastography examinations were performed by experienced radiologists using a high-resolution ultrasound machine equipped with elastography software to assess the stiffness of hepatic lesions. Elastographic patterns and strain ratios were recorded to categorize lesions as benign or malignant. Subsequently, contrast-enhanced CT scans were performed and interpreted independently by radiologists who were blinded to the elastography findings. CT imaging findings were considered the reference (gold standard) for the final classification of hepatic lesions. All relevant clinical and imaging data were documented on a structured data collection proforma.

The qualitative variables included gender, type of hepatic lesion (benign or malignant), elastography pattern, and CT findings indicating benign or malignant lesions. The quantitative variables included age of the patients (in years), lesion size

(in centimeters), and strain ratio values obtained from elastography. Data were analyzed using statistical software. Diagnostic accuracy parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of strain elastography were calculated by comparing elastography findings with CT scan results. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 110 patients with suspected focal hepatic lesions who met the inclusion criteria were included in the study. The mean age of the participants was 45.8 ± 13.6 years, with an age range of 20–70 years. Among the study population, 68 (61.8%) were males and 42 (38.2%) were females. Based on CT scan findings (gold standard), 62 (56.4%) lesions were malignant, while 48 (43.6%) were benign. The mean lesion size was 3.6 ± 1.4 cm, and the mean strain ratio measured on elastography was 4.8 ± 2.1 .

Strain elastography categorized 65 lesions as malignant and 45 lesions as benign. When the elastography findings were compared with CT scan results, 56 lesions were true positives, 39 were true negatives, 9 were false positives, and 6 were false negatives. These results indicated that strain elastography showed a high ability to differentiate malignant from benign hepatic lesions.

Based on the comparison with CT scan findings, the sensitivity of strain elastography for detecting malignant hepatic lesions was 90.3%, the specificity was 81.3%, the positive predictive value (PPV) was 86.2%, the negative predictive value (NPV) was 86.7%, and the overall diagnostic accuracy was 86.4%. These findings demonstrate that strain elastography is a useful non-invasive imaging technique for the differentiation of benign and malignant hepatic lesions, although CT remains the reference standard for definitive diagnosis.

Table 1: Demographic and Clinical Characteristics of Patients (n = 110)

Variable	Frequency (n)	Percentage (%)
Age (Mean $\pm$ SD)	45.8 ± 13.6 years	—
Gender		
Male	68	61.8%
Female	42	38.2%
Lesion Type on CT (Gold Standard)		
Benign Lesions	48	43.6%
Malignant Lesions	62	56.4%
Mean Lesion Size	3.6 ± 1.4 cm	—
Mean Strain Ratio	4.8 ± 2.1	—

Table 2: Comparison of Strain Elastography with CT Scan for Differentiation of Hepatic Lesions

Strain Elastography Findings	CT Malignant	CT Benign	Total
Malignant	56 (True Positive)	9 (False Positive)	65
Benign	6 (False Negative)	39 (True Negative)	45
Total	62	48	110

Diagnostic Performance of Strain Elastography

Parameter	Value
Sensitivity	90.3%

Specificity	81.3%
Positive Predictive Value (PPV)	86.2%
Negative Predictive Value (NPV)	86.7%
Overall Diagnostic Accuracy	86.4%

DISCUSSION

A total of 110 patients with suspected focal hepatic lesions were included in this study, with a mean age of 45.8 ± 13.6 years (range: 20–70 years), indicating that focal liver lesions are commonly encountered in middle-aged individuals. Male predominance (61.8%) was observed, which is comparable with previously reported data. A study conducted in 2020 also highlighted that sonoelastography is a non-invasive imaging modality with high diagnostic accuracy for differentiating benign and malignant nodules (11).

In the present study, CT scan, taken as the gold standard, identified 62 (56.4%) malignant lesions and 48 (43.6%) benign lesions. The mean lesion size was 3.6 ± 1.4 cm, while the mean strain ratio on elastography was 4.8 ± 2.1 , indicating higher stiffness in malignant lesions compared to benign ones. Similarly, a study conducted in 2019 reported that ultrasound elastography can objectively assess tissue stiffness, while contrast-enhanced ultrasound evaluates vascularity, and their combined use improves diagnostic accuracy in focal liver lesions (12).

Strain elastography categorized 65 lesions as malignant and 45 as benign. When compared with CT findings, 56 cases were true positives, 39 true negatives, 9 false positives, and 6 false negatives. These values reflect that elastography correctly identified the majority of malignant lesions while maintaining a reasonable ability to exclude benign lesions. A 2025 study also emphasized that triphasic CT demonstrates very high sensitivity in differentiating focal liver lesions, although specificity may be affected by background liver changes (13).

The diagnostic performance of strain elastography in this study showed a sensitivity of 90.3%, indicating a high ability to correctly identify malignant lesions. The specificity was 81.3%, suggesting moderate capability in ruling

out benign lesions. The positive predictive value (86.2%) and negative predictive value (86.7%) further support its reliability in clinical practice. The overall diagnostic accuracy was 86.4%, demonstrating that strain elastography is an effective modality for lesion characterization. Supporting these findings, a 2025 study reported that shear wave elastography has high sensitivity and specificity, allowing reliable differentiation between benign and malignant hepatic lesions (14).

Despite its high sensitivity, the presence of 9 false-positive and 6 false-negative cases highlights certain limitations of strain elastography. False negatives may occur in smaller lesions (mean size 3.6 cm) or lesions with heterogeneous composition, while false positives may be due to fibrosis, inflammation, or overlapping stiffness characteristics between benign and malignant lesions. Additionally, elastography is operator-dependent and can be affected by technical factors such as probe pressure and patient cooperation.

CT imaging remains superior for detailed lesion characterization, assessment of vascular patterns, and detection of associated findings. Therefore, while elastography provides valuable preliminary information regarding tissue stiffness, CT continues to serve as the definitive imaging modality. Similarly, a study conducted in 2021 reported that strain elastography has considerable diagnostic accuracy in differentiating benign and malignant lesions when compared with gold-standard techniques (15).

Overall, the findings of this study demonstrate that strain elastography has a high sensitivity (90.3%) and good overall diagnostic accuracy (86.4%) in differentiating benign from malignant hepatic lesions. However, due to its relatively lower specificity (81.3%) and presence of false results, it should be used as a complementary tool rather than a replacement for CT. An integrated

imaging approach combining elastography for initial assessment and CT for confirmation provides the most reliable strategy for accurate diagnosis and management of focal liver lesions.

CONCLUSION

Strain elastography demonstrated good diagnostic performance in differentiating benign and malignant hepatic lesions, with high sensitivity and acceptable specificity when compared with computed tomography (CT) as the gold standard. The findings suggest that strain elastography is a valuable, non-invasive, and cost-effective imaging technique for the initial assessment of focal liver lesions. It can assist clinicians in improving early detection and characterization of hepatic lesions. However, CT imaging remains essential for definitive diagnosis and detailed evaluation of lesion characteristics.

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