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Original Research Article

Utility of Sonoelastography in Characterisation of Thyroid Nodules

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Abstract:

Background: The majority of thyroid nodules that are inadvertently found are benign and asymptomatic. Though the malignant nodules make up 5% of thyroid nodules, they must be diagnosed accurately for clinical reasons. While conventional ultrasonography is a reliable method for identifying thyroid nodules, it is not possible to distinguish between benign and malignant nodules. The primary drawback of FNA cytology is that 10–15% of specimens are indeterminate and 10–15% are nondiagnostic. FNA cytology is invasive and vulnerable to errors in sampling and analysis. Thus, there is a need to enhance and perfect non-invasive techniques to diagnose malignant lesions. Palpable thyroid nodule stiffness is a subjective measure that cannot reliably predict cancer. It has been demonstrated that sonoelastography is helpful in differentiating between benign and malignant tumours. In contrast to the surrounding normal tissues, the majority of benign tumours are softer, whereas the majority of malignant tumours are stiff and hard. Thus, the purpose of this study was to illustrate the diagnostic precision and usefulness of sonoelastography in identifying thyroid nodules that are benign or malignant.

Methods: This cross-sectional study, which involved 41 patients with thyroid nodules was carried out in the radiology department of a tertiary care hospital between September 2017 and October 2018. Strain sonoelastography was carried out during the conventional ultrasound examination of the thyroid gland. The 'Rago' criteria-based sonoelastography colour scoring system was applied. The trial participants subsequently had a ultrasound-guided FNA cytology of the lesions. SPSS 22 version software was used for data analysis after the data was entered into a Microsoft Excel data sheet. Frequencies and proportions were used to depict categorical data. For qualitative data, the chi-square test or Fischer's exact test was employed as the significance test. The mean and standard deviation were used to depict continuous data. Data visualisation was done using Microsoft Word and Excel to create a variety of graphs, including pie charts and bar charts.

Results: The majority of these individuals (41.5%) were in the age range of 31 to 40. 90.2% of the patients were female. In the B-mode, there were 5.1% malignant lesions, 23.7% indeterminate lesions, and 71.2% benign lesions. 13.6% of elastography scores were 1, 66.1% were 2, 10.2% were 3, 8.5% were 4, and 1.7% were 5. 10.2% of the lesions were determined to be malignant and 89.8% to be benign based on the elastography scores. In reference to sonoelastography, only 66.7% of the malignant lesions and 33.3% benign lesions were found to be picked up in B-mode sonography; similarly, among those indeterminate lesions of B-mode sonography, 14.3% were found to be malignant and 85.7% to be benign on sonoelastography; and among those benign lesions of B-mode sonography, 4.8% were found to be malignant and 95.2% were benign by sonoelastography. Among the thyroid nodules, 88.1% of lesions were found to be benign based on FNAC/HPE, whereas 11.9% were found to be malignant. Colloid goitre (22%), papillary carcinoma (10.2%), and follicular carcinoma (1.7%) made up the majority of the study findings, with hyperplastic nodules accounting for 66.1%. All the malignant lesions identified by B-mode sonography were found to be concordant in HPE (100%); 14.3% of those with B-mode indeterminate lesions were found to be malignant by FNA cytology/ HPE and 85.7% to be benign; 2 benign lesions of B-mode (4.88%) were found to be malignant. Thus, the B - mode sonography had a sensitivity of 42.86%, specificity of 100%, PPV of 100%, NPV of 95.24% with diagnostic accuracy of 95.56% in diagnosis of malignant lesions in comparison with HPE. Sonoelastography showed a sensitivity of 85.71%, specificity of 100%, PPV of 100%, NPV of 98.1% with diagnostic accuracy of 98.3% in the diagnosis of malignant lesions in comparison with

HPE. Combined sonoelastography and B Mode sonography showed a 100% sensitivity, specificity and NPV of 100% with diagnostic accuracy of 100% in diagnosis of malignant lesions in comparison with HPE.

Conclusion: An imaging method that shows promise for characterising thyroid nodules is sonoelastography. When B-mode and sonoelastography are used together, the outcomes are superior to when they are used separately.

Keywords: Sonoelastography, Elastography, Thyroid Nodules, Ultrasound. B-mode sonography.

Introduction

A thyroid nodule is a common condition that affects 8.5% of people. According to a recent study, the community's prevalence of a palpable thyroid nodule in India is approximately 12.2%.[1] The majority of thyroid nodules that are incidentally found are benign and asymptomatic. Though the malignant nodules make up 5% of thyroid nodules, they must be diagnosed accurately for clinical reasons and to enable early treatment of patients with malignant lesions. While conventional ultrasonography is a reliable method for identifying thyroid nodules, it is not always possible to distinguish between benign and malignant nodules. The American Thyroid Association guidelines state that no one sign or set of features in the US is sensitive or specific enough to identify every malignant nodule.[2] hence the nodules larger than 10 mm or those exhibiting questionable ultrasonography signals must undergo fine needle aspiration cytology.

Fine needle aspiration cytology is the most effective single test for distinguishing between benign and malignant thyroid lesions. The primary drawback of FNA cytology is that 10–15% of specimens are indeterminate and 10–15% are nondiagnostic.[3] It is invasive and vulnerable to errors in sampling and analysis. Haemorrhagic cysts, multinodular goitres, or insufficient cell samples are the causes of these diagnostic failures. Consequently, a considerable proportion of individuals ultimately have needless thyroid surgery. Thus, there is a need to enhance and perfect non-invasive techniques to identify the malignant lesions with high probability and accuracy.

There are many criteria / indicators of malignancy in the conventional ultrasound imaging like nodule echogenicity, microcalcification, blurred or spiculated margin, absent halo sign, and abnormal vascularity. The stiffness of thyroid nodules by clinical examination upon palpation is subjective and cannot be an accurate indicator for malignancy and does not directly provide information about hardness of a nodule.

Sonoelastography is developed as a non-invasive method of measuring tissue stiffness. The basis of sonoelastography is the measurement of the degree of tissue deformation in response to the application of an external force, which allows for the reconstruction of tissue stiffness. Tissue stiffness may be objectively determined since the softer tissues deform more easily under compression than the harder tissues.[4] It has been demonstrated that sonoelastography is helpful in differentiating between benign and malignant tumours. In contrast to the surrounding normal tissues, the majority of benign tumours are softer, whereas the majority of malignant tumours are stiff and hard.

Despite its usefulness, sonoelastography can provide false positives when it comes to benign nodules that have coarse calcifications. It is insensitive to follicular thyroid carcinomas and is unable to provide meaningful information in cases of fully liquid cystic lesions.

Thus, the purpose of this study was to illustrate the diagnostic accuracy and usefulness of sonoelastography in identifying thyroid nodules that are benign or malignant.

Materials & Methods

This is a cross-sectional study conducted in the tertiary care hospital between September 2017 and October 2018, involving 41 patients with thyroid nodules referred to the Radiology Department. Purely cystic nodules and nodules with the presence of calcified shell were excluded from the study.

The B- mode sonography was performed using a SAMSUNG (H-60) ultrasound machine using linear transducer of frequency 7 to 13 Mhz for all thyroid nodules followed by color-power Doppler with the patient being examined in the supine position, with the neck extended.

The following ultrasound parameters was evaluated in thyroid nodules **(Image 1 A to F)**:

- Presence or absence of halo sign
- Echogenicity-iso/hypo/hyper.
- Microcalcification-presence/absence.
- Margins of nodule.
- Doppler-peripheral flow/intranodular flow.

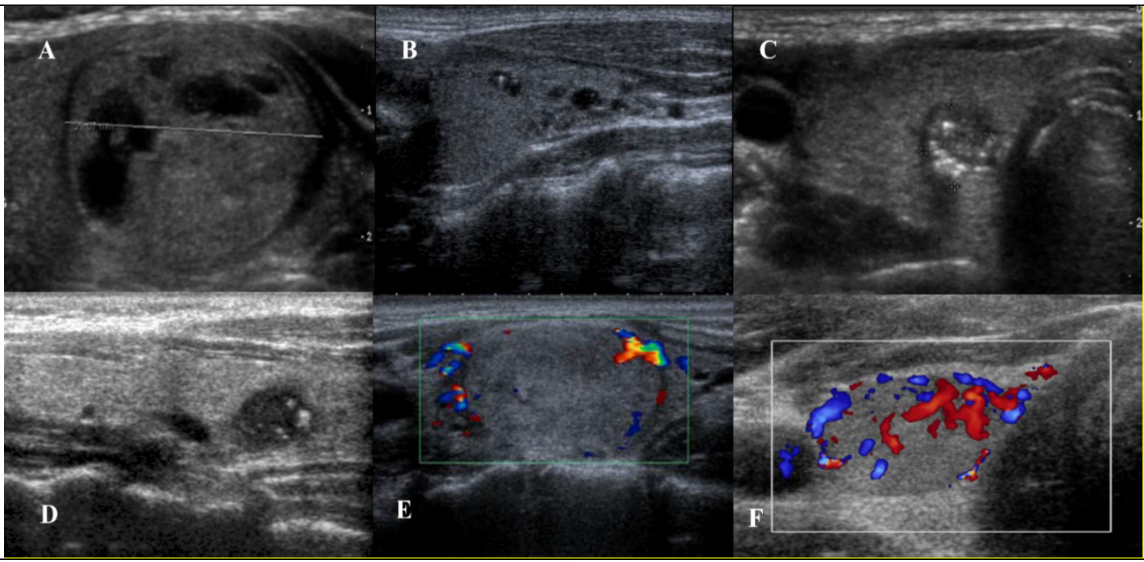


Image 1: A: Benign nodules- hyper/ isoechoic nodule with cystic change. B: Multiple colloid nodules within the thyroid with ring down sign. C & D: Patterns of calcifications in a thyroid nodule: C- Typical benign peripheral/ "egg shell" calcification. D- Solid hypoechoic lesion with micro-calcification –papillary carcinoma. E & F: Colour flow pattern – E-Benign - hyperechoic nodule relative to thyroid, halo, peripheral colour flow with no significant intra nodular flow. F- Malignant intra nodular, chaotic blood flow pattern.

Sonoelastography was also carried out during the conventional ultrasound examination of the thyroid gland. The sonoelastography method used is strain elastography, also known as static or compression elastography. The linear probe was placed on the neck with light pressure and a box was highlighted by the operator to include the nodule under examination in the center of the region of interest (ROI). A 50% allowance around the nodule was included in the ROI where attainable. Gentle repetitive compression was then applied. Adequate compression displayed a green color on all the compression bars at the top of the image. An elastogram was then displayed over the conventional ultrasound image in a color scale. These results were interpreted using a elasticity score system. It converts the tissue stiffness information into a color-coded image known as an elastogram. This is superimposed on a grey scale image of the region of interest. In general, stiff tissues are coded as blue, while soft tissues are red. Tissues with average stiffness are coded as green/yellow. Sonoelastography color scoring system according to Rago-5 criteria was used as shown in **Table 1 and image 2**.

Table 1: Rago Criteria

Score	Characteristics
1	Uniform strain or elasticity across the lesion (that is, the lesion and its surroundings are both uniformly coloured green).
2	Elasticity or strain throughout the majority of the lesion, with some places showing no strain (i.e., a green and blue mosaic pattern)
3	Elasticity or strain at the lesion's periphery, sparing the lesion's centre (i.e., the lesion's outside portion is shown as green and its inside portion as blue).
4	There is no elasticity or strain throughout the lesion; in other words, the surrounding area is not included but the lesion itself is blue.
5	The entire lesion and its surroundings are blue, indicating that there is no strain or flexibility in any location.

Subsequently, the study subjects underwent a traditional or ultrasound-guided FNA cytology of the lesions.

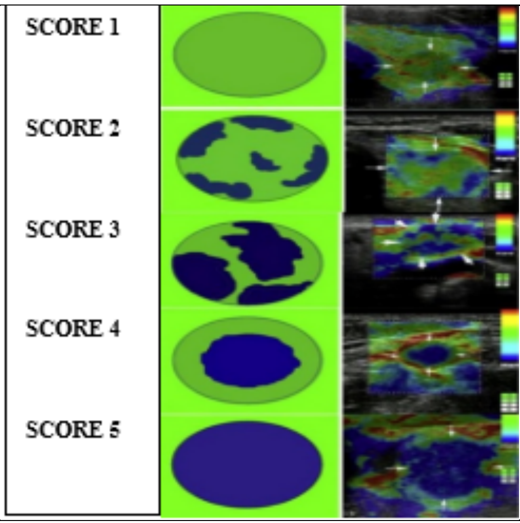
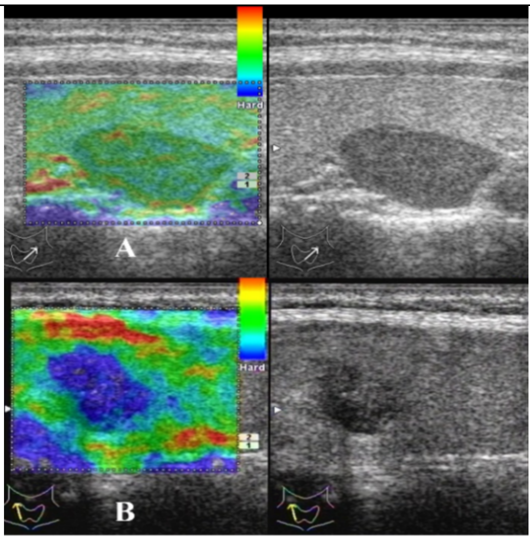


Image 2: Rago Criteria Image



3 A & B

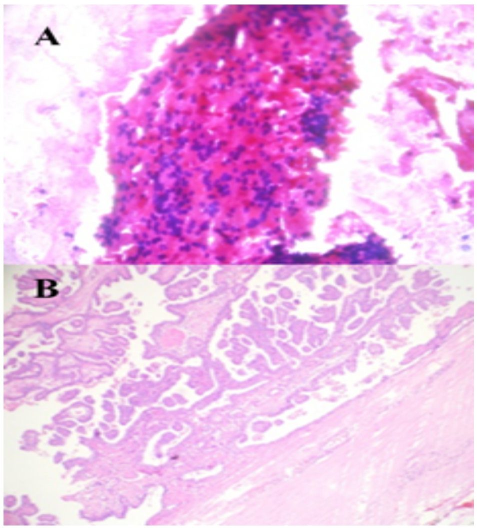


Image 4 A & B

Images 3 & 4 Sonoelastography appearance of nodules: 3 A: Adenomatoid nodule: Left: real-time elastogram of the thyroid nodule shows completely elastic (score 1). **Right**: B-mode sonogram of the nodule shows hypoechoic and well-circumscribed margin. **3 B: Papillary carcinoma: Left:** real-time elastogram of the thyroid nodule shows anelastic in the nodule and elastic surrounding tissues (score 5). **Right:** B-mode sonogram of the nodule shows hypoechoic and poorly-circumscribed margin.

4A. Cytology of an Adenomatoid Nodule (H&E stain, high power) showing cohesive sheets of follicular epithelial cells with abundant colloid and minimal atypia. **4B. Histopathology of Papillary Thyroid Carcinoma** (H&E stain, low power) showing papillary structures lined by neoplastic epithelial cells

Statistical Analysis: SPSS 22 version software was used for data analysis after the data was entered into a Microsoft Excel data sheet. Frequencies and proportions were used to depict categorical data. The significance test for qualitative data was the chi-square test or Fischer's exact test (for 2x2 tables only). The mean and standard deviation were used to depict continuous data. Data visualisation was done using Microsoft Word and Excel to create a variety of graphs, including pie charts and bar charts.

Results

A total of 59 nodules in these 41 patients who had thyroid nodules were evaluated for the study. Ninety-two percent of the population was over thirty years old between the ages of 31 and 40 (41.5%). 37 of the 41 patients (90.2%) were female.

There were three different types of thyroid nodules in the subjects: five had three, eight had two, and 28 had just one.

In the study, by B Mode snography, 5.1% were Malignant, 23.7% were Indeterminate, 71.2% were Benign (**Table 2)**. Similarly, 13.6% had a score of 1, 66.1% had a score of 2, 10.2% had a score of 3, 8.5% had a score of 4, and 1.7% had a score of 5. **(Table 3).** Based on the elastography scores (Rago criteria 4 and 5), 10.2% were found to be malignant lesions, and 89.8% were benign lesions.

Table 2: Elastography Scores among Nodules

		Count	%
Elastography scores	1	8	13.6%
	2	39	66.1%
	3	6	10.2%
	4	5	8.5%
	5	1	1.7%

Table 3: Diagnosis of Lesions by B Mode

		Count	%
B Mode	Malignant	3	5.1%
	Indeterminate	14	23.7%
	Benign	42	71.2%

In reference to sonoelastography, only 66.7% of the malignant lesions and 33.3% benign lesions were found to be picked up in B-mode sonography; similarly, among those indeterminate lesions of B-mode sonography, 14.3% were found to be malignant and 85.7% were benign on sonoelastography; and among those benign lesions of B-mode sonography, 4.8% were found to be malignant and 95.2% to be benign by sonoelastography **(Table 4)**.

Table 4: Comparison between B-Mode and Elastography

		B Mode					
		Malignant		Indeterminate		Benign	
		Count	%	Count	%	Count	%
Elastography	Malignant	2	66.7%	2	14.3%	2	4.8%
	Benign	1	33.3%	12	85.7%	40	95.2%
$\chi 2 = 12.08$, df = 2, p = 0.002*							

Among the thyroid nodules, 88.1% of lesions were found to be benign based on FNAC/HPE, whereas 11.9% were found to be malignant. Colloid goitre (22%), papillary carcinoma (10.2%), and follicular carcinoma (1.7%) made up the majority of the study findings, with hyperplastic nodules accounting for 66.1% (**Tables 5 and 6**).

Table 5: Classification of thyroid nodules among subjects based on FNAC/HPE

		Count	%
FNAC/HPE	Benign	52	88.1%
	Malignant	7	11.9%

Table 6: Diagnosis of thyroid nodules among subjects based on FNAC/HPE

		Count	%
Diagnosis of thyroid nodules	Hyperplastic Nodules	39	66.1%
	Colloid nodule	13	22.0%
	Papillary Carcinoma	6	10.2%
	Follicular Carcinoma	1	1.7%

The results show that hypoechogenicity was more accurate than HPE at finding cancerous growths. It had a sensitivity of 57.14%, a specificity of 100%, a PPV of 98.08%, an NPV of 80%, and a diagnostic accuracy of 93.22%. When comparing the ill-defined margin to HPE for the diagnosis of malignant lesions, the former had a sensitivity of 42.86%, a specificity of 88.46%, a PPV of 33.33%, a NPV of 92%, and a diagnostic accuracy of 83.05%. In comparing micro calcification to HPE, the results showed that it was 42.86% sensitive, 96.15% specific, 60% positive predictive value, 92.59% negative predictive value, and 89.83% accurate in diagnosing malignant lesions. Intranodular vascularity had a sensitivity of 57.14%, a specificity of 94.23%, a PPV of 57.14%, a NPV of 94.23% and a diagnostic accuracy of 89.83% in the diagnosis of malignant lesions in comparison with HPE.

Ultrasound characteristics to identify thyroid malignant nodules are as in the Table 7.

Table 7: Ultrasound Features for the Identification of Malignant Thyroid Nodules

		Malignant	Benign	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Hypoechogenicity	Present	4	1	57.14%	98.08%	80%	94.44%	93.22%
	Absent	3	51					
Ill-defined margin	Present	3	6	42.86%	88.46%	33.33%	92%	83.05%
	Absent	4	46					
Micro calcification	Present	3	2	42.86%	96.15%	60%	92.59%	89.83%
	Absent	4	50					
Intranodular Vascularity	Present	4	3	57.14%	94.23%	57.14%	94.23%	89.83%
	Absent	3	49					

Table 8: Comparison between B-Mode and FNAC/HPE

		B-Mode					
		Malignant		Indeterminate		Benign	
		Count	%	Count	%	Count	%
FNAC/HPE	Malignant	3	100.0%	2	14.3%	2	4.8%
	Benign	0	0.0%	12	85.7%	40	95.2%
$\chi 2 = 24.3$, df = 2, $p < 0.001$*							

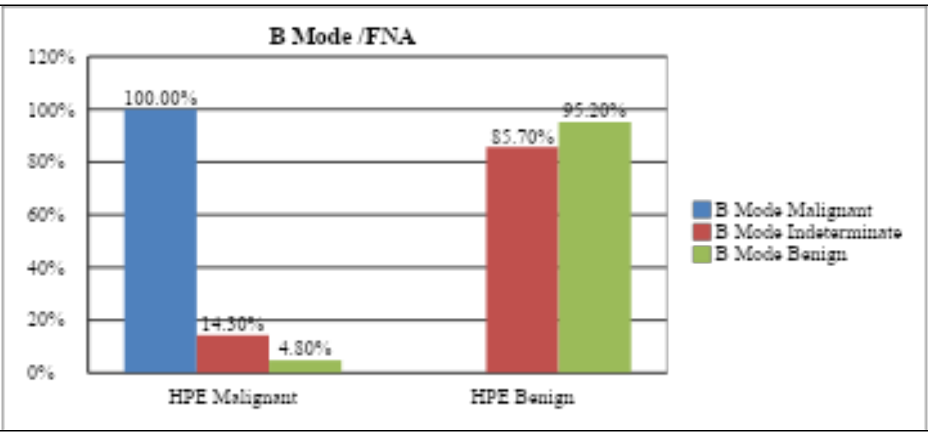


Figure 1: Bar Diagram Showing Comparison between B-Mode and Elastography

All the malignant lesions identified by B-mode sonography were found to be concordant in HPE (100%); 14.3% of those with B-mode indeterminate lesions were found to be malignant by FNA cytology/ HPE and 85.7% to be benign; 2 benign lesions in B-mode (4.88%) were found to be malignant. There was a significant correlation between HPE and B-mode findings (**Table 8, Figure 1**).This corelated to the identification of benign and malignant lesions by sonoelastography among the indeterminate and benign lesions found by B- mode sonography, indicating the potential accuracy of sonoelastography in the diagnosis of malignant lesions. Thus, the B - mode sonography had a sensitivity of 42.86%, specificity of 100%, PPV of 100%, NPV of 95.24% with diagnostic accuracy of 95.56% in diagnosis of malignant lesions in comparison with HPE.

Of the 7 malignant lesions in HPE, 6 were identified in sonoelastography as malignant and 1 lesion was falsely categorised as benign (85.7% and 14.3% respectively) indicating significant association between elastography and HPE in the diagnosis of malignant and benign lesion (**Table 9 and Figure 2**).

Table 9: Comparison between Elastography and FNA/HPE

		HPE			
		Malignant		Benign	
		Count	%	Count	%
Elastography	Malignant	6	85.7%	0	0.0%
	Benign	1	14.3%	52	100.0%
$\chi 2 = 49.61$, df = 1, $p < 0.001$*					

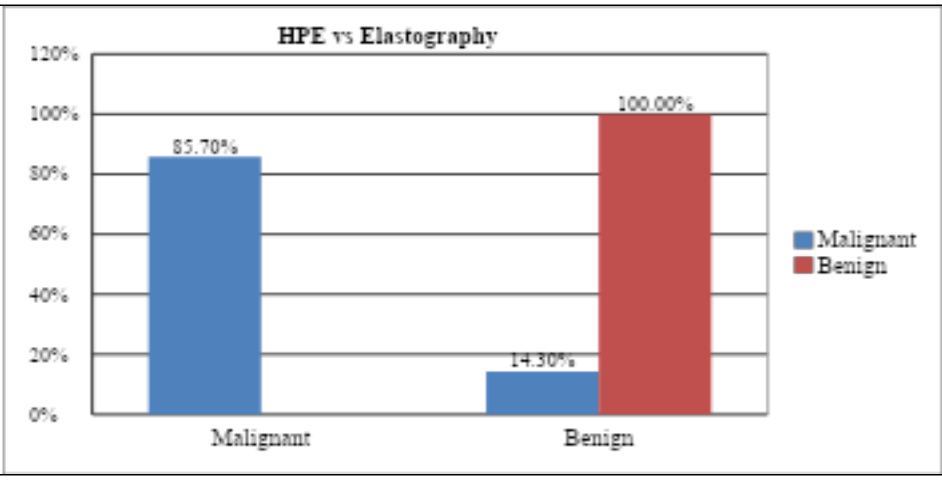


Figure 2: Bar diagram showing Comparison between HPE and Elastography

Of the 7 malignant lesions by FNA cytology/HPE, the B-mode sonography was able to correctly identify 3 lesions as malignant, whereas 2 lesions each were falsely identified as indeterminate and benign. Similarly, 12 benign lesions were identified as indeterminate and 40 of 52 lesions were correctly categorised as benign by B-mode sonography. However, the combined imaging by B-mode sonography and sonoelastography showed 100% accuracy in identifying malignant and benign lesions (**Table 10 and Figure 3).** There was a significant correlation between B-mode and combined [elastography + B-mode] with respect to HPE.

Table 10: Comparison of B-Mode and Combined [Elastography + B Mode] Modalities in Diagnosis of Malignant and Benign Lesions with Respect to FNAC/HPE

		HPE				P value
		Malignant		Benign		
		Count	%	Count	%	
B Mode	Malignant	3	42.9%	0	0.0%	<0.001*
	Indeterminate	2	28.6%	12	23.1%	
	Benign	2	28.6%	40	76.9%	
Combined [Elastography + B Mode]	Malignant	7	100.0%	0	0.0%	<0.001*
	Benign	0	0.0%	52	100.0%	

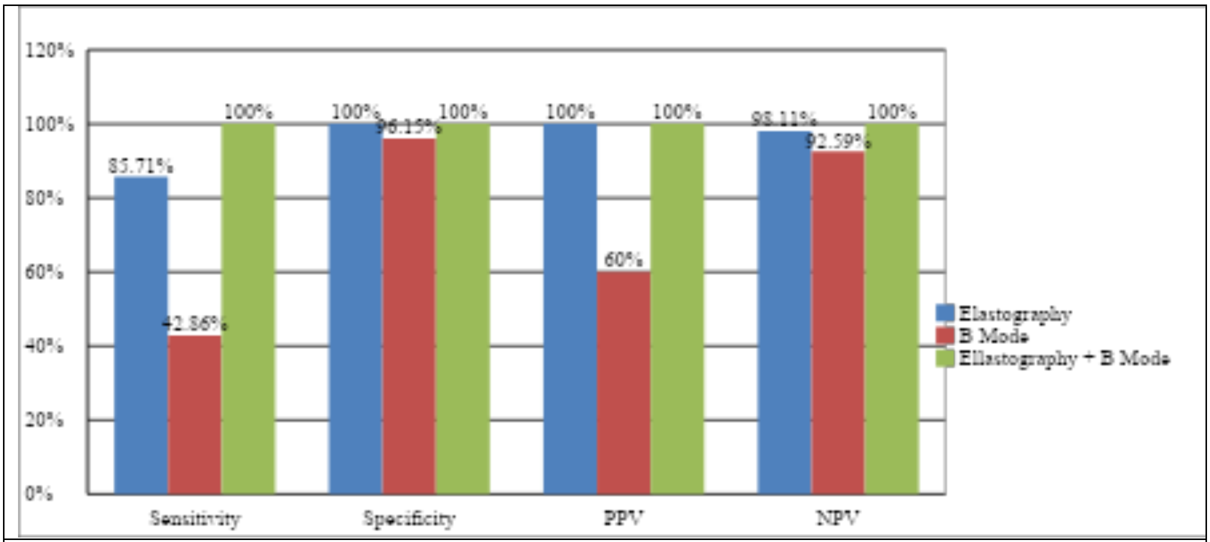


Figure 3: Bar diagram showing Validity of Elastography, B Mode and Combined (B Mode + Elastography) in diagnosing Malignant lesion with respect to HPE

When comparing B-mode to HPE for the identification of malignant lesions, it showed a sensitivity of 42%, a specificity of 96.15%, a PPV of 60%, a NPV of 92.59%, and a diagnostic accuracy of 89.83%. When comparing sonoelastography to HPE for the diagnosis of malignant lesions, the former showed a sensitivity of 85.71%, a specificity of 100%, a PPV of 100%, a NPV of 98.11%, and a diagnostic accuracy of 98.31%. When compared to HPE, the combined method of [elastography + B-mode] demonstrated 100% sensitivity, specificity, PPV, NPV, and diagnostic accuracy in the identification of malignant lesions. **(Table 11).**

Table 11: Validity of Elastography, B Mode and Combined (B Mode + Elastography) in Diagnosing Malignant Lesion with Respect to HPE

		Malignant	Benign	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Elastography	Malignant	6	0	85.71%	100%	100%	98.11%	98.31%
	Benign	1	52					
B Mode	Malignant	3	2	42.86%	96.15%	60%	92.59%	89.83%
	Benign	4	50					
Elastography + B Mode	Malignant	7	0	100%	100%	100%	100%	100%
	Benign	0	52					

Discussion

Even though the majority of thyroid nodules are benign, identifying the difference between malignant and benign nodules is crucial for choosing the right course of treatment. For professionals, a differential diagnosis is still a challenging issue. Because elastography can reflect the tissue stiffness associated with malignant tumours, it has become an important tool in the categorization of thyroid nodules. Numerous studies have demonstrated how well elastography works to distinguish between benign and malignant nodules. [6-8] However, some research has shown the opposite outcome. [9,10]

With 92.9% of the sample, people over 30 years of age made up the majority in this study. About 41% of these patients were between the ages of thirty and forty and the most of them were female. In a related study, the mean age of patients with benign nodules was 48.30 ± 10.86 years, while the mean age of patients with malignant nodules was 42.49 ± 11.39 years, according to Hairu, L. et al.[11]

There were 41 patients with 59 thyroid nodules in this study. After every lesion was examined using Sonoelastography and B-mode, FNA cytology/HPE was applied to every lesion. 52 of the 59 nodules on FNA cytology/HPE were benign, and 7 were malignant.

When compared to HPE, hypoechogenicity in this study showed a sensitivity of 57.14%, a specificity of 100%, a PPV of 98.08%, an NPV of 80%, and a diagnostic accuracy of 93.22% in the identification of malignant lesions. When comparing the ill-defined margin to HPE for the diagnosis of malignant lesions, the former had a sensitivity of 42.86%, a specificity of 88.46%, a PPV of 33.33%, a NPV of 92%, and a diagnostic accuracy of 83.05%. In comparing micro calcification to HPE, the results showed that it was 42.86% sensitive, 96.15% specific, 60% positive predictive value, 92.59% negative predictive value, and 89.83% accurate in diagnosing malignant lesions. In comparing Intranodular vascularity to HPE, it demonstrated a sensitivity of 57.14%, specificity of 94.23%, PPV of 57.14%, NPV of 94.23%, and diagnostic accuracy of 89.83% for the detection of malignant lesions.

When multiple characteristics are present in a single thyroid nodule, the likelihood of the nodule being malignant increases. Specific characteristics that raise doubts about malignancy include hypervascularity, irregular and ill-defined borders, microcalcifications, and the absence of a halo. These traits, which can be identified via the US, have reportedly been found to be sensitive but insufficiently specific.[12]

By the B-mode sonography, 5.1% of lesions were malignant, 23.7% were indeterminate and 71.2% were benign. When comparing B-mode with FNA cytology/HPE for the identification of malignant lesions, B-mode had a sensitivity of 42.86%, a specificity of 100%, a PPV of 100%, a NPV of 95.24%, and a diagnostic accuracy of 95.56%. When diagnosing benign and malignant tumours, B-mode and HPE showed a strong correlation.

It has been suggested that thyroid nodule stiffness serves as a separate predictor of thyroid cancer.[13] Additionally, it has been claimed that elastography, a recently implemented method that evaluates nodule stiffness, improves specificity by overcoming the drawbacks of traditional B-mode and Doppler US, and as a result, shows promise in the detection of malignant lesions.[14]

Following the 2007 report by Rago et al.[15] on the use of elastography as a novel technique with great potential for the diagnosis of thyroid cancers, numerous retrospective and prospective studies evaluating thyroid nodules by elastographic methods using various scoring systems and comparing with pathology or FNAC results among various patient groups have been published in the literature to date.[16-18] These studies' main objective was to show the viability, advantages, and predictive values of non-invasive techniques like sonoelastography in order to reduce the number of patients who would require surgery or be referred for invasive diagnostic procedures.

In the current sonoelastography research, 10.2% of the lesions were malignant while 89.8% were benign. When comparing sonoelastography to HPE for the diagnosis of malignant lesions, the former showed a sensitivity of 85.71%, a specificity of 100%, a PPV of 100%, a NPV of 98.11%, and a diagnostic accuracy of 98.31%. When diagnosing benign and malignant lesions, sonoelastography and HPE showed a strong correlation.

Similarly, Giovanardi et al. study [19] evaluated diagnostic accuracy of sonoelastography in the differential diagnosis of thyroid cancer. In these patients, 86 nodules underwent evaluation using ultrasonography B-mode, ultrasonography colour-power-Doppler, and sonoelastography. The FNA cytology led to the final diagnosis. There were 69 benign nodules and 17 malignant ones. The sonoelastography's sensitivity and specificity for the detection of thyroid cancer were 94.1% and 81%, respectively. Comparing the technique's accuracy to our study findings, it was less accurate at 83.7%.

Consecutive 92 patients with a single thyroid nodule who underwent surgery for compressive symptoms or a fine needle aspiration cytology suspicion of malignancy were included in T. Rago, F. Santini, et al. study.[20] Using US elastography, 49 instances (all benign lesions) had scores of 1 or 2, 13 cases (one carcinoma and 12 benign lesions), and 30 cases (all carcinomas) had scores of 4 or 5. Therefore, with a sensitivity of 97%, specificity of 100%, positive predictive value of 100%, and negative predictive value of 98%, the elasticity scores 4-5 were strongly predictive of malignancy ($p<0.0001$). In 32 patients with an uncertain fine needle aspiration result, the conventional US did not show any signs of cancer. However, six out of seven (86%) patients with carcinoma on histology had a sonoelastography score of 4-5, while all 25 patients with benign lesions had a score of 1-3.

Hamad Elniel H. Eltyib et al. evaluated the predictive value of real-time ultrasound elastography (RUE) in distinguishing benign from malignant thyroid nodules.[21] This prospective study investigated 78 consecutive patients with thyroid nodules who were chosen for fine-needle aspiration biopsies. With a sensitivity of 93.7% and a specificity of 90%, 15 of 16 malignant nodules had a score of 3 to 5, whereas 47 of 62 benign nodules (76%) had a score of 1 or 2. The study found that because real-time ultrasound elastography's high elasticity is strongly correlated with benign cytology, it is a potential imaging method that can be helpful in the differential diagnosis of thyroid cancer and its use could lower the number of thyroid biopsies.

Through the use of sonoelastography, Ragazzoni et al. [22] studied 132 nodules (92 benign and 40 malignant) and found that 77 of the 92 benign nodules were classified as scores of 1 or 2, and 34 of the 40 malignant nodules as scores of 3 or 4 (sensitivity 85%, specificity 83.7%, PPV 69.3%, and NPV 92.7%). After analysing 17 malignant and 69 benign lesions, Asteria et al. [23] reported that the elastography's sensitivity, specificity, PPV, NPV, and accuracy were, in that order, 94.1%, 81%, 55.2%, 98.2%, and 83.7%. After analysing 23 thyroid nodules, Ferrari et al. [24] found that 88% of malignant nodules had patterns 3–4, while 78% of benign nodules had patterns 1-2. The results of the same investigation showed that elastography had the following characteristics: 88%, 78%, 72%, 91%, and 82% for sensitivity, specificity, PPV, NPV, and diagnostic accuracy.

In a prospective evaluation of 97 patients, Cantisani et al. [25] observed that lesions with a strain ratio ≥2 were most likely malignant in nature and that the sensitivity and specificity of elastography were 97.3% and 91.7%, respectively. In a different study, Cantisani et al. [26] assessed 89 benign and 58 malignant cases that had thyroidectomies and discovered that, when the elastography score was taken into consideration, the sensitivity and specificity were, respectively, 93% and 89%. As per the study, elastography yielded more precise results in comparison to colour Doppler US and US.

By analysing the research done on real-time elastography for differentiating benign from malignant thyroid nodules, Bojunga et al.[27] conducted a meta-analysis and found that elastography was helpful for patients having surgery. A meta-analysis of 8 studies with a total of 639 nodules found that the overall mean sensitivity for diagnosing malignant thyroid nodules was 92% (CI = 88–96) and the overall mean specificity was 90% (CI = 85–95). Another meta-analysis by Ghajarzadeh et al.[28] examined the diagnostic accuracy of sonoelastography in identifying malignant nodules by thoroughly reviewing 12 studies that assessed 1180 thyroid nodules. They found that a threshold elasticity score of between 1 and 2 of 98.3% (95% CI, 96.2%–99.5%) produced the maximum sensitivity. Additionally, they stated that more invasive testing was not required for the patients with an elasticity score of 1. When the cutoff value for malignancy was taken to be score 4, Akcay et al.[29] evaluated 110 nodules based on stiffness score using US elastography and found that the sensitivity, specificity, PPV, and NPV were 100%, 95%, 40%, and 100%, respectively; they advised biopsy for all score 4 nodules but not for score 1. In the current investigation, strain elastography revealed that all nodules in patterns 1 and 2 were benign, but 61.7% of the nodules in patterns 3 and 4 were malignant. Compared to studies in the literature, our study included a larger sample size of the population. It was found that the sonoelastography sensitivity, specificity, PPV, NPV, and accuracy were, in that order, 100%, 80.2%, 61.7%, 100%, and 85.0%.

When comparing elastography and B-mode to HPE, the combined results showed 100% sensitivity, specificity, PPV, NPV and diagnostic accuracy in the detection of malignant lesions. Therefore, in the diagnosis of malignant and benign lesions, there was a substantial correlation between HPE and combined elastography + B-mode.

Similar to this study, investigation by Mohamed Shweela's study, Ehab Mansourb et al,[30] assessed the diagnostic efficacy of combined HRUS (High-Resolution Ultrasonography) with sonoelastography to distinguish between benign and malignant thyroid nodules. The sensitivity, specificity, diagnostic accuracy, positive predictive, and negative predictive values for thyroid nodules by sonoelastography was 75.4%, 85.5%, 86.7%, 71.4%, and 90.5% respectively. Similarly for thyroid nodules by HRUS had 92.0% sensitivity, 72.9% specificity, 60.1% diagnostic accuracy, 95.0% positive predictive value, and 63.1% negative predictive value. The diagnostic performance was higher when both US techniques were used together; the sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were 95.4%, 94.8%, 95.2%, 82.3%, and 98.8%, respectively.

Conclusion

Sonoelastography is a very useful additional tool in the imaging of thyroid nodules. When B-mode sonography and sonoelastography are used together for evaluation of thyroid nodules, the outcomes are superior due to high diagnostic accuracy than when they are used separately, thus reducing the need for invasive thyroid FNA cytology / biopsies.

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