Original Article

Role of Elastography in Differentiating Malignant and Benign Thyroid

Maham Munir Awan[1], Malik Mudasir Hassan[2], Hina Hanif Mughal[3], Faisal Mehmood[4]

[1]Associate Professor of Radiology, Nishtar Medical University, Multan.
[2]Associate Professor of Radiology, Quaid e Azam Medical College Bahawalpur
[3]Associate Professor of Radiology/ HOD Radiology Benazir Bhutto Hospital, RMU, Rawalpindi
[4]Assistant Professor Radiology, Rawalpindi Medical University

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Address of Correspondent
Dr Maham Munir Awan
Associate Professor of Radiology,
Nishtar Medical University,
Multan
maham.amj@hotmail.com

ABSTRACT

Objective: To determine the efficacy of elastography in differentiating between malignant and benign thyroid nodules, using fine needle aspiration cytology (FNAC) as the reference standard.

Methodology: This cross-sectional study was conducted at the Radiology Department of Nishtar Hospital, Multan, from January 2023 to December 2023. A total of 180 patients with one or more solid thyroid nodules diagnosed on conventional ultrasound were enrolled in the study. After obtaining consent, all patients underwent strain elastography under standard protocol, and the findings were compared with cytological results. Sensitivity was calculated using the formula: True Positives / (True Positives + False Negatives). Specificity was calculated as: True Negatives / (True Negatives + False Positives). Positive predictive value (PPV) was calculated as: True Positives / (True Positives + False Positives). Negative predictive value (NPV) was calculated as: True Negatives / (True Negatives + False Negatives). Diagnostic accuracy was determined using the formula: (True Positives + True Negatives) / (True Positives + True Negatives + False Positives + False Negatives). All these values were calculated using a 2x2 contingency table.

Results: The study included a total of 180 patients with an average age of 46.38±12.21 years, 76.1% of whom were male and 23.9% female. Among the patients, 9.4% had malignant thyroid nodules, while 90.6% had benign nodules as determined by elastography and confirmed by FNAC. In terms of diagnostic accuracy, 13 patients were true positives (both positive on cytology FNAC and ultrasound elastography), whereas 7 patients were false positives (negative on cytology FNAC but positive on ultrasound elastography).

Conclusion: Elastography has high efficacy in differentiating malignant from benign thyroid nodules and can potentially replace fine needle aspiration cytology (FNAC).

Keywords: Elastography, Thyroid nodules, Fine needle aspiration, Benign, Malignant.

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Introduction

Nodular thyroid disease is indeed a common endocrine disorder that affects people of all genders and age groups.[1] It refers to the occurrence of nodules or unusual growths in the thyroid gland, situated at the front of the neck, responsible for producing hormones that regulate metabolism.[2] The prevalence of nodular thyroid disease is influenced by various factors, including geographical location, iodine deficiency, and exposure to goitrogens[3]. In the case of South Asian populations, including Pakistan, iodine deficiency and the use of goitrogens contribute to the higher prevalence of thyroid diseases.[4]

Ultrasonography (USG) is commonly used to detect thyroid nodules, but it may not be sufficient to differentiate between benign and malignant nodules with a high level of accuracy[5]. Fine needle aspiration cytology (FNAC) is a

procedure often performed on suspicious nodules to obtain cells for analysis.[6] It has a specificity range of 60% to 98% and a sensitivity range of 54% to 90%, indicating its effectiveness in identifying malignant nodules.[7] However, FNAC has limitations, as around 10% to 15% of aspirates may be nondiagnostic.[7]

Ultrasound elastography, also known as sonoelastography, is an imaging technique that provides information about the stiffness or hardness of tissues.[8] It is considered a useful adjunctive tool to conventional ultrasound (USG) in assessing thyroid lesions and improving diagnostic accuracy. This technique can help differentiate between benign and malignant thyroid nodules.[9] The primary advantage of ultrasound elastography is that it provides additional information without the need for an invasive procedure like a repeat biopsy. Biopsies can be cumbersome for patients and can pose a financial burden on both patients and healthcare systems, especially in countries with limited resources.[10]

Methodology

A cross-sectional study was carried out in the Radiology Department of Nishtar Hospital, Multan, spanning from January 2023 to December 2023. The sample collection was done using a non-probability consecutive sampling technique. The study commenced after receiving approval from the hospital's ethical board, and written informed consent was obtained from all patients, ensuring the confidentiality of their information. The sample size of 180 patients was calculated based on a study conducted by Nazir et al[13] which reported a 93.3% sensitivity of FNAC for benign nodules. The sample size was determined using OpenEpi.com, with a 99% confidence interval and a 5% margin of error.

Patients aged 20 to 60 years, of both genders, and with ultrasonically diagnosed solid thyroid nodules up to 15 mm in size were included in the study. Exclusion criteria were solid cystic nodules, nodules occupying 75% or more of a thyroid lobe, nodules with peripheral calcification, and patients who refused to give consent.

Thyroid ultrasounds (USG) and sonoelastography were conducted using the Toshiba Aplio 500 ultrasound machine, equipped with a 5 MHz probe. The ultrasound examinations took place in a dimly lit room maintained at a comfortable temperature between 22°C and 24°C. Patients were positioned supine with their necks hyperextended for optimal imaging. Before the ultrasound examination, primary and demographic data, such as gender, age, address, medical record number, and clinical history, were recorded. Grayscale ultrasonography was used to visualize thyroid size and location, providing clear images of the gland and aiding in the identification of abnormal areas.

After the initial ultrasound, elastography was performed to assess the elasticity and stiffness of the nodules. Elastography provides detailed characterization of benign and malignant thyroid nodules by analyzing stiffness and elasticity. A numerical representation of five patterns was used in this technique. The strain ratio, which compares the elasticity of the nodule to the surrounding tissue, was calculated.

FNAC, considered the gold standard for confirming the nature of the nodules, was performed using 22–25-gauge needles to obtain a sample from the nodule, which was then examined under a microscope. The FNAC report for each nodule was used to compare with the findings from sonoelastography and strain ratio measurements. This comparison helped determine the accuracy and reliability of sonoelastography in diagnosing thyroid nodules.

For data analysis, the Statistical Package for Social Sciences (SPSS) version 23.0 was used. Quantitative variables, such as age, were presented as mean ± standard deviation (SD), while proportions (frequencies) were calculated for categorical variables. To evaluate the performance of sonoelastography in relation to cytology, a 2 x 2 contingency table was constructed, likely comparing the results of sonoelastography (positive/negative) against the cytology results (true positive, true negative, false positive, and false negative).

Results

The study included a total of 180 patients with an average age of 46.38±12.21 years, with males comprising 76.1% and females 23.9%. Among them, 9.4% had malignant thyroid nodules, while 90.6% had benign ones. (Figure 1)

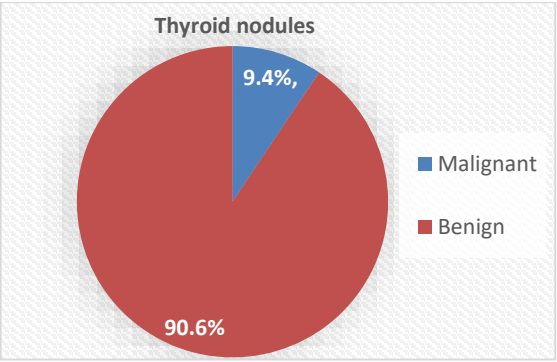

Figure I. Thyroid nodule diagnosed with elastography by taking FNAC reference standard.

In terms of diagnostic accuracy, 13 patients showed both positive cytology FNAC and positive ultrasound elastography (true positive), whereas 7 patients had negative cytology FNAC but positive ultrasound elastography (false positive).

Table I: Demographic profile of the patients.

	Occurrence
Age (years)	46.38±12.21
Gender	
Male	137 (76.1)
Female	43 (23.9)
Mean±SD, N (%)	

Additionally, 22 patients had positive cytology FNAC but negative ultrasound elastography (false negative), and 138 patients had negative results in both tests (true negative), yielding a statistically significant difference ($p<0.001$). The sensitivity, specificity, positive predictive value, and negative predictive value were found to be 37.1%, 95.1%, 65.0%, and 86.3%, respectively, with an overall accuracy of 83.9% assessed by designing 2x2 contingency table.

Table II: Role of ultrasound elastography in differentiating benign from malignant thyroid nodule s by using FNAC as reference standard

Ultrasound Elastography	Cytology FNAC		Total	p-value
	Malignant (Positive)	Malignant (Negative)		
Positive	True positive 13	False positive 7	20	<0.001
Negative	False negative 22	True negative 138	160	
Total	35	145	180	

Discussion

Another ultrasound technique that estimates tissue stiffness is sonoelastography which is used for assessment of qualitative needs of the target tissue and helps diagnose malignant thyroid nodules. This non-invasive and painless method highlights fine details of thyroid nodules.[11] Strain elastography is especially important for characterizing thyroid nodules. Recent consensus suggests that a hard and firm, nodule nature is considered to be malignant. FNAC is the preferred diagnostic method. However, FNAC is invasive, and very small only 10 to 15% of nodules remain indeterminate.[12]

Male dominancy was observed in results of this study as 76.1% male population and mean age of patients was 46.38±12.21. In the study conducted by Nazir et al[13] it was found that 42.42% of the participants were males, while 57.58% were females. Additionally, 61.82% of the participants were between 18-40 years of age, and 38.18% were between 41-60 years of age. The mean age ± standard deviation was calculated to be 35.81 ± 9.03 years. In another contrast study conducted by Elaggan et al[14] electronic medical reports of 137 patient subjects were reviewed and evaluated, revealing that the majority of the subjects were females (n=123, 89.8%), while only a minority were males (n=14, 10.2%). In this study, the sensitivity of elastography was found to be 37.1%, indicating its ability to accurately detect true positive cases. This was accompanied by a specificity of 95.1%, highlighting its proficiency in correctly identifying true negative cases.

In contrast, a study conducted by Idrees et al[15] in 2023 evaluated the diagnostic performance of son elastography in distinguishing between benign and malignant nodules, using cytology as the gold standard. Results of this study shows 90.0% sensitivity and 90.0% specificity. Positive predictive value was 91.5% and negative predictive value 88.2%, hence diagnostic accuracy was 90%.

In a study Wuguo et al[16] reported 2.52 strain ratio as cutoff value when start to differentiate benign and malignant nodules of thyroid. Study reported 85.7% sensitivity and specificity was 90.5% showing negative predictive values. Nell et al[17] concluded that elastography is a suitable alternative of FNAC in terms of differentiating thyroid nodules. Another study by Afifi et al[18] reported a sensitivity of 80% and specificity of 100% ($p<0.001$) for elastography, highlighting its diagnostic accuracy. Furthermore, suggested that combining sonography and elastosonography enhances efficacy compared to using them separately.

In a study Colakoglu et al[19] reported it is a potential tool for distinguishing between benign and malignant thyroid nodules and aiding in clinical decision-making having sensitivity 100%, specificity 80.2%, PPV 61.7%, NPV 100%, and accuracy you mentioned 100%, suggest the performance of strain elastography in benign and malignant nodules differentiation.

The utilization of elastography as a diagnostic technique for thyroid cancers was reported by Rago et al in 2007.[20] Since then, numerous retrospective and prospective studies have been conducted to evaluate thyroid nodules using elastographic methods. Chong et al[21] discovered that while the use of elastography is beneficial in predicting malignant thyroid nodules, incorporating strain ratio (SR) into color mapping does not enhance performance compared to using color mapping alone.

Conclusion

Elastography have high efficacy to differentiate malignant thyroid nodules and benign thyroid nodules and can be used in replacement of fine needle aspiration cytology.

Limitations: The primary limitations of this study include a small sample size and the fact that it was conducted at a single center. Additionally, a significant portion of the study population came from remote or underdeveloped areas, where many individuals declined to participate due to social and religious constraints.
Suggestions: In routine diagnosis of thyroid nodules elastography should be performed for accurate identification of nature of nodule either it's benign or malignant.

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