IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 7 Ser.2 (July 2025), PP 12-16
www.iosrjournals.org

Role of Ultrasound Elastrography in Various Thyroid Nodules with Cytological / Histopathological Correlation

Dr. Vinod Kumar Mogha[1], Dr. Neeraj Prajapati[2], Dr. Namrata[3], Mrs. Priyanka Saxena[4]

[1]*Assistant Professor, Department of Radio-diagnosis*
[2.] *Professor, Department of Radio-diagnosis*
[3.] *Associate Professor, Department of Radio-diagnosis*
[4.] *Assistant Professor, Department of Radiology*
Corresponding Author- Dr. Vinod Kumar Mogha, Assistant Professor, Department of Radio-diagnosis, SRMSIMS, Bareilly (UP)

ABSTRACT
Introduction: *Elastography is a newly developed dynamic technique that uses ultrasound to provide an estimation of tissue stiffness by measuring the degree of distortion under the application of an external force. Ultrasound elastography has been applied to differentiate malignant from benign lesions.*
Materials and Methods: *This study included 53 consecutive patients with thyroid nodules. High resolution ultrasound elastography examination, scoring and further fine needle aspiration cytology was done in all of the cases. Tissue stiffness on ultrasound elastography was scored from on (greatest elastic strain) to five (no strain).*
Results: *Fifty three cases were evaluated by real time ultrasound elastography. Seventeen (33%), 22 (39%), 6 (12%), 6 (12%), 2 (4%) were assigned score of 1,2,3,4 and 5 respectively. The elasticity scores 4-5 were highly predictive of malignancy with a sensitivity of 87.5%, a specificity of 97.6%, a positive predictive value of 87.5%, and a negative predictive value of 97.6%.*
Conclusion: *Ultrasound elastography has great potential as an adjunctive tool for the diagnosis of thyroid cancer. Larger prospective studies are needed to confirm these results and establish the diagnostic accuracy of this new technique.*
Keywords*: ultrasound elastography, thyroid nodules*

Date of Submission: 24-06-2025 Date of Acceptance: 04-07-2025

I. Introduction

A thyroid nodule is the result of abnormal growth of thyroid cells containing benign or malignant cells within the thyroid gland. The main clinical concern for managing thyroid nodules is to exclude malignant diseases which account for 4% to 6% of all thyroid benign nodules.[1] Early detection and accurate diagnosis are extremely important in management of such patients.

Palpation is the oldest and most frequently used screening method for detecting thyroid gland tumors. In general, almost 5% of the adult population has a palpable thyroid gland nodule. Palpation becomes very difficult for clinicians when the nodule is small or located deep in the thyroid tissue.[2]

FNAC has proved to be an efficient tool for the diagnosis of thyroid nodules. FNA with cytological evaluation has become the accepted method for screening a thyroid nodule for cancer, in the hands of an experienced cytologist, FNA has a high accuracy rate[5].

Evaluation of the thyroid gland can be performed by using several imaging techniques like plain radiography, high resolution ultrasonography, computed tomography, magnetic resonance imaging and radionuclide imaging.

The prevalence of thyroid nodules increases with age. The likelihood that a nodule is malignant, is affected by a variety of risk factors. Malignancy is more common in nodules found in patients who are younger than 20 or older than 60 years of age than in patients between 20 and 60 years of age.

II. Materials and Methods

The study is time bound study comprised a total of patients of suspected nodular thyroid disease. This study included 55 consecutive patients with thyroid nodules.

Clinical history was obtained along with physical examination. The verbal informed consent was also taken before the examination.

High resolution ultrasound elastography examination was carried out using Acuson S2000 system (Siemens Medical Solutions) having capability of color doppler and sonoelastography and a linear array transducer (Siemens Medical Solutions) with a centre frequency of 7.5 MHz (range, 5.0–14.0 MHz).

After B scan examination, a sectional elastographic examination is performed. The region of interest used for obtaining elasticity images is set to include sufficient surrounding thyroid tissue. The real-time elastogram and the grey-scale ultrasound image are displayed simultaneously in dual mode. The resultant elastogram is displayed over the B-mode image and assessed using a colour scale: red indicated ' hard tissue', green indicated 'medium stiffness' of the tissue and blue indicated 'soft tissue' . To classify elasticity images, the colour pattern of the thyroid lesion relative to the surrounding tissue is evaluated.

Elastography scoring and further fine needle aspiration cytology was done in all of cases. Tissue stiffness on ultrasound elastography was scored from one, ie, greatest elastic strain to five, ie, no strain (Fig. 2-7)

Score of 1 indicated even elasticity in the whole nodule.
Score of 2 indicated elasticity in a large part of the nodule.
Score of 3 indicated elasticity only at the peripheral part of the nodule.
Score of 4 indicated no elasticity in the nodule.
Score of 5 indicated no elasticity in the nodule or in the area showing posterior shadowing.[4]

III. Results

The present study was conducted in the Department of Radiodiagnosis, Shri Ram Murti Institute of Medical Sciences, Bareilly, Uttar Pradesh in 55 patients presenting with symptoms and signs suggestive of a thyroid nodule.

A complete history of patients was taken along with detailed clinical examination. Clinical examination involved both local and systemic examination in thyroid disorders. High resolution ultrasonography with elastography was performed in all patients. Out of which 2 were found to have a normal thyroid gland and hence were excluded from the present study. In all 53 cases elastography findings of various thyroid nodules were correlated with cytological/ histopathological findings.

Out of the 53 cases evaluated by real time ultrasound elastography, 17 were assigned score of 2, all benign lesions;6 were assigned a score of 3, 1 malignant and 5 benign lesions; 6 were assigned a score of 4, 1 benign and 5 malignant lesions & 2 were assigned a score of 5, all malignant lesions (fig.-8)

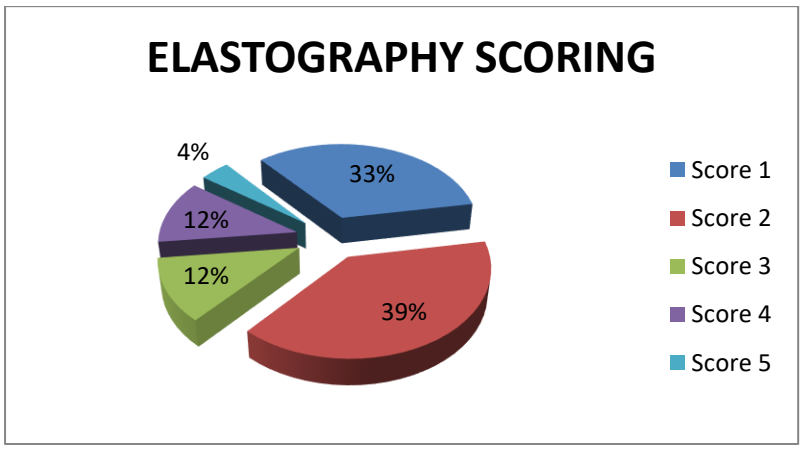

Figure-8- Elastography scoring

On cytological evaluation, out of 53 patients having nodules, 43 had benign nodular, 8 had malignant nodular and two were inconclusive (Table-1,2).

Table 1:Results of FNAC in benign nodules

Diagnosis	Number of Cases
Colloid goitre with cystic degeneration	23
Colloid goitre	15
Benign adenomatous nodule	3
Autoimmune thyroiditis	1
Lymphocytic thyroiditis	1
Total	45

Table 2:Results of FNAC in malignant nodules

Diagnosis	Number of cases
Papillary Carcinoma	5
Follicular Carcinoma	2
Medullary Carcinoma	1
Total	8

On correlation of FNAC findings with real time ultrasound elastography findings, it was noted that in our series out of 53 patients, 2 patients had inconclusive results on FNAC hence they were excluded from the study. Out of the rest 51 cases, there was 1 false negative diagnosis of malignancy, ie, nodule of 1 patient was diagnosed as benign on elastography that was found out to be malignant on FNAC, and 1 false positive diagnosis of malignancy, ie nodule of 1 patient was diagnosed as malignant on elastography but was found out to be benign on FNAC.

Real time ultrasound elastography score of 1 to 3 were classified as benign and score of 4 to 5 ($P<0.001$) were classified as malignant. The correlation coefficient is calculated to be 0.8.

Thus, the elasticity scores 4-5 were highly predictive of malignancy with a sensitivity of 87.5%, a specificity of 97.6%, a positive predictive value of 87.5%, and a negative predictive value of 97.6%.

Table-3: USG strain elastography with cytological correlation

	Malignant on FNAC	Benign on FNAC	Total
Malignant on USG	7	1	8
Benign on USG	1	42	43
Total	8	43	51

Following observations were made:

Patient's age ranged between 15 to 80 years with a mean age of 41.3 years.

Thyroid nodules were more common in 4^{th} and 5^{th} decade females.

Females outnumbered the males in the proportion of 6.4 :1.

Right lobe is the commonest site of thyroid nodules. 22 were detected in right lobe.

A clinically firm nodule did not correlate with the echo pattern and included a variety of lesions solid, cystic and mixed type.

Swelling in the thyroid region was the most common clinical feature seen in 39 cases. Various other symptoms noted were difficulty in swallowing, difficulty in breathing, hoarseness of voice, gradual to rapid increase in size of mass and movement of mass with deglutition.

Majority of thyroid nodules were euthyroid. Hypothyroididsm was noted in benign disorders like adenoma and thyroiditis.

High resolution ultrasonography is capable of detecting small non palpable thyroid nodules incidentally.

Differentiation of solid, cystic and mixed echogenicity of nodule on real time ultrasound elastography helps to differentiate high risk cases from low risk cases.

Real time ultrasound elastography revealed 45 cases as benign and 8 cases as malignant.

FNAC of thyroid nodule revealed 43 benign cases and 8 malignant cases.
Solid nodules had a higher incidence of malignancy than cystic or mixed nodules.
On real time ultrasound elastography score of 1 to 3 suggests benign lesions where as a score of 4 or 5 suggests malignant lesion.
Real time ultrasound elastography had 1 false negative and 3 false positive diagnosis of malignancy.
The specificity of real time ultrasound elastography in our series is 97.6% and sensitivity 87.5%.
The positive predictive value & negative predictive value of real time ultrasound elastography in our series is 87.5% & 97.6% respectively.

IV. Discussion

Real-time ultrasound elastography was first implemented by Ophir et al in 1991 and was designed on the basis of the mechanism that softer parts of tissues deform more easily than harder parts under compression. The degree of distortion of a tissue under an external force can be recorded, thus allowing an objective determination of tissue stiffness.[1]

The elasticity of tissues has been studied by several authors with different approaches. As the conventional ultrasound does not provide information regarding the hardness of the nodule, real time ultrasound elastography is a newly developed dynamic technique that evaluates the degree of distortion of a tissue under the application of an external force and is based up on the principle that the softer parts of tissues deform easier than the harder parts under compression, thus allowing an objective determination of tissue consistency. Malignant lesions are often associated with changes in the mechanical properties of a tissue, and US elastography has been used to differentiate cancers from benign lesions in prostate, breast, pancreas, and lymph nodes.[5]

The sensitivity of real time ultrasound elastography in predicting malignancy out of 53 patients in our series is 87.5% & the specificity is 97.6%. Several other studies have used ultrasound elastography for evaluation of thyroid nodules. Many of them reported variable sensitivity and specificity of real time USE for predicting malignancy. Lyshchik A et al[6] had a sensitivity and specificity of 82 % and 96% respectively in their series.

Rago T et al[7] study included 92 consecutive patients with a single thyroid nodule. Tissue stiffness on US elastography was scored from on (greatest elastic stain) to five (no strain). On US elastography: scores 1 and 2 were found in 49 cases, all benign lesions; score 3 in 13 cases, one carcinoma and 12 benign lesions; and scores 4 and 5 in 30 cases, all carcinomas. Thus, the elasticity scores 4-5 were highly predictive of malignancy (P 0.0001), with a sensitivity of 97%, a specificity of 100%, and a negative predictive value of 98% showed ultrasound elastography has great potential as an adjunctive tool for the diagnosis of thyroid neoplasms, especially in indeterminate nodule on cytology.[5]

Hong Y et al (2009) examined one hundred forty-five nodules in 90 patients by B-mode ultrasound, color doppler ultrasound, and ultrasound elastography. The final diagnosis was obtained from histologic findings. Tissue stiffness on ultrasound elastography was scored from 1 (low stiffness over the entire nodule) to 6 (high stiffness over the entire nodule and surrounding tissue). On real-time ultrasound elastography, 86 of 96 benign nodules (90%) had a score of 1 to 3, whereas 43 of 49 malignant nodules (88%) had a score of 4 to 6 (P <.001), with sensitivity of 88%, specificity of 90%, a positive predictive value of 81%, and a negative predictive value of 93%. The predictivity of ultrasound elastographic measurement was independent of the nodule size. High sensitivity (88%) and specificity (93%) were also observed in 68 nodules that had a greatest diameter of 1 cm or less. Hence concluding real-time ultrasound elastography is a promising imaging technique that is useful in the differential diagnosis of thyroid cancer.[7]

Merino S et al (2011) One-hundred three consecutive patients with 106 thyroid nodules were examined prospectively with conventional B-mode sonography and real-time US elastography. All patients were referred for FNAB. In their study, pattern of stiffness based on gray-scale and classification proposed were statistically significant and predicted malignancy with 100% sensitivity and 40.6% specificity. Tumor size when compared with B-mode images or margins was not statistically significant in their study. No false-negatives were found, and a negative predictive value of 100% was seen. Hence concluded that ultrasound elastography is a promising technique that can assist in the evaluation of thyroid nodules and can potentially diminish the number of FNAB procedures needed.[8]

Sun J et al (2014) This meta-analysis was performed to assess the diagnostic power of ultrasound elastography in differentiating benign and malignant thyroid nodules for elasticity score and strain ratio assessment. A total of 5481 nodules in 4468 patients for elasticity score studies and 1063 nodules in 983 patients for strain ratio studies were analyzed. The overall mean sensitivity and specificity of ultrasound elastography for differentiation of thyroid nodules were 0.79 (95% confidence interval [CI], 0.77–0.81) and 0.77 (95% CI, 0.76–0.79) for elasticity score assessment and 0.85 (95% CI, 0.81–0.89) and 0.80 (95% CI, 0.77–0.83) for strain ratio assessment, respectively. These results confirmed those obtained in the previous meta-analysis. Ultrasound

elastography has high sensitivity and specificity for identification of thyroid nodules. It is a promising tool for reducing unnecessary fine-needle-aspiration biopsy.[1]

Kanagaraju, et al (2020) With scanty literature comparing elastography with FNAC available from this part of the world, our study highlights that elastography has a fairly high diagnostic accuracy and correlation with malignant cytology. It can be an effective noninvasive adjunctive tool in distinguishing benign from malignant thyroid nodules and reduce the burden of unnecessary invasive procedures.[9]

Cantisani V et al (2022) on 72 studies & 13505 patients, the pooled sensitivity, specificity and area under curve were 78%, 81% and 0.87 for Shearwave elastography for which authors used the term "Quantitative elastography". These results were similar to results found in our study.[10]

Daisy Gupta et al (2024) Thyroid nodules were found to be more common in females as compared to males (83% Vs 17%). Elastoscan scoring based on Ueno & Ito classification3 with a cut off of ≥4.0 was found to have 92% diagnostic accuracy in differentiating malignant from benign thyroid nodules with a sensitivity & specificity of 76.1% & 96.2% respectively (p = 0.000). Strain elastography (E-strain) with a cut-off of ≥1.70 had a diagnostic accuracy of 91.0% in differentiating benign from malignant thyroid nodules with a sensitivity & specificity of 95.2% & 89.9% respectively. It was found to be highly significant in differentiating malignant from benign thyroid nodules (p = 0.000).

Strain elastography offer valuable additions to the diagnostic toolbox, particularly for solid and non-calcified nodules. These techniques demonstrate high reliability and accuracy in differentiating between malignant and benign nodules, making them a valuable complement to FNAC (fine needle aspiration cytology).[11]

V. Conclusion

Our study indicates that real time ultrasound elastography has good diagnostic efficacy for differentiation of various thyroid nodules. On real time ultrasound elastography score of 1 to 3 suggests benign lesions where as a score of 4 or 5 suggests malignant lesion.

It can be used as a supplementary tool with gray scale sonography for confirming fine needle aspiration cytology.

Larger prospective studies are needed to confirm these results and establish the diagnostic accuracy of this new technique.

Reference

[1]. Sun J, Cai J, Wang X : Real-time Ultrasound Elastography for differentiation of Benign and Malignant Thyroid Nodules. J Ultrasound Med 2014; 33:495–502

[2]. Zhang Y, He Y, Xu HX, Lui C, Guo LH, Lui LN et al: Virtual Touch Tissue Imaging on Acoustic Radiation Force Impulse Elastography. J Ultrasound Med 2014; 33:585–95

[3]. Wang Y, Dan H-J, Dan H-Y, Li T, Hu : Differential Diagnosis of Small Single Solid Thyroid Nodules using real time ultrasound elastography. Journal of International Medical Research 2010; 38:466

[4]. Rago T, Scutari M, Santini F, Loiacono V, Raggi P, Coscio G et al : Real-Time Elastosonography: Useful Tool for Refining the Presurgical Diagnosis in Thyroid Nodules with Indeterminate or Non diagnostic Cytology. J Clin Endocrinol Metab, December 2010;95:5274–80

[5]. Rago T, Santini F et al. Elastography: New Developments in Ultrasound for Predicting Malignancy in Thyroid Nodules. The Journal of Clinical Endocrinology & Metabolism 2007;92:2917–2922

[6]. Lyshchik A, Higashi T, Asato R, Tanaka S, Ito J, Mai J et al: Thyroid Gland Tumor Diagnosis at ultrasound elastography. Radiology 2005; 237:202–11

[7]. Hong Y, Liu X, Li Z, Zhang X, Chen M, Luo Z: Real time ultrasound elastography in the differential diagnosis of benign and malignant thyroid nodule. J.Ultrasound med 2009;28:861-867.

[8]. Merino S, Arrazola J, Cardenas A, Mendoza M, Miguel P, Fernandez C et al: Utility and Interobserver Agreement of Ultrasound Elastography in the Detection of Malignant Thyroid Nodules in Clinical Care. AJNR 32 :Dec 2011.

[9]. Kanagaraju V, Sukithra S, Jayaprakash N, Devan B. Utility of ultrasound elastography in evaluation of thyroid nodules and correlation with cytology. West African Journal of Radiology. 2020 Jan 1;27(1):52-7.

[10]. Cantisani V, De Silvestri A, Scotti V, Fresilli D, Tarsitano MG, Polti G, et al. US-Elastography With Different Techniques for Thyroid Nodule Characterization: Systematic Review and Metaanalysis. Front Oncol. 2022 Mar 16;12:845549.

[11]. Gupta D, Kumar H, Bagga PK, Ohri P, Kumar H. Role Of Ultrasound Elastography In Evaluation Of Thyroid Nodules With FNAC/Histopathological Correlation. International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 8, August 2024