Original research article

THYROID NODULES EVALUATION BY STRAIN ULTRASOUND ELASTOGRAPHY AND HISTOCYTOLOGICAL CORRELATION

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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.

Material 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 one (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.

INTRODUCTION

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.[1]Before the advent of high resolution ultrasound capability, radionuclide scintigraphy was the chief means to evaluate the thyroid gland both functionally and morphologically. CT and MRI are used in the evaluation of thyroid masses, but are not as sensitive as ultrasound in the detection of intra thyroidal lesions but are used in the evaluation of mediastinal extension of thyroid masses.[2]

To enhance the diagnostic ability of sonography, ultrasound elastography, including static and real-time elastography has been introduced into the clinic with an aim of improving the diagnosis of thyroid nodules.[3]A thyroid nodule that is clinically firm to hard and consistent is associated with an increased risk of malignancy.

The principle of elastography imaging is based on evaluating differential tissue characteristics regarding rigidity versus elasticity. Elastography is used complementary to conventional USG for improving the diagnosis of thyroid tumors, that appear harder than the surrounding tissue.[4]

Real-time ultrasound elastography is one of the most widely used technique. It is a newly developed dynamic technique that reflects the deformation or distortion of tissue in response to the application of an external compression load (Fig.-1). Elastography combines the detection advantages of high resolution ultrasound with cancer diagnostic information. On the elastogram, different colour modes imply different tissue stiffness, thereby offering more information with respect to differentiation between benign and malignant lesions.[2]

MATERIAL AND METHODS

The study was a hospital based prospective study of patients with suspected nodular thyroid disease. This study included 55 consecutive patients with thyroid nodules.

Clinical history was obtained along with physical

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examination. The verbal informed consent was also taken before the examination.

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

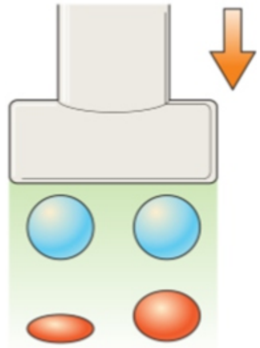

Figure-1: Strain elastography evaluates elasticity through tissue displacement caused by compression, with the degree of displacement being larger in soft tissue than in hard tissue.[5]

After B scan examination, a sectional elastographic examination was performed. The region of interest used for obtaining elasticity images was set to include sufficient surrounding thyroid tissue. The real-time elastogram and the grey-scale ultrasound image were displayed simultaneously in dual mode. The resultant elastogram was 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 was evaluated.

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

RESULTS

Figure-2: Score of 1 indicates even elasticity in the whole nodule, Score of 2 indicates elasticity in a large part of the nodule, Score of 3 indicates elasticity only at the peripheral part of the nodule, Score of 4 indicates no elasticity in the nodule, Score of 5 indicates no elasticity in the nodule or in the area surrounding it / showing posterior shadowing.[6]

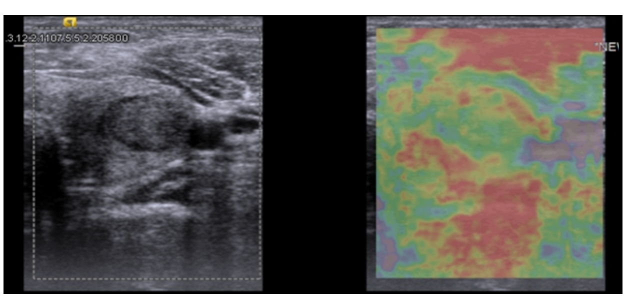

Figure-3 : Scroe of 1 indicates even elasticity in whole nodule.

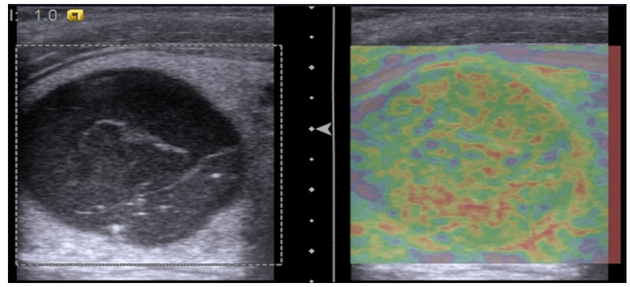

Figure-4 : Score of 2 indicates elasticity in a large part of the nodule.

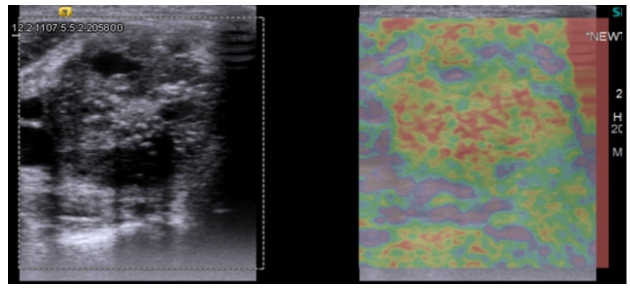

Figure-5 : Score of 3 indicates elasticity only at the peripheral part of the nodule.

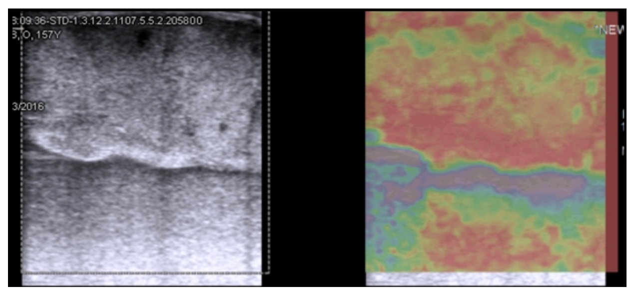

Figure-6 : Score of 4 indicates no elasticity in the nodule.

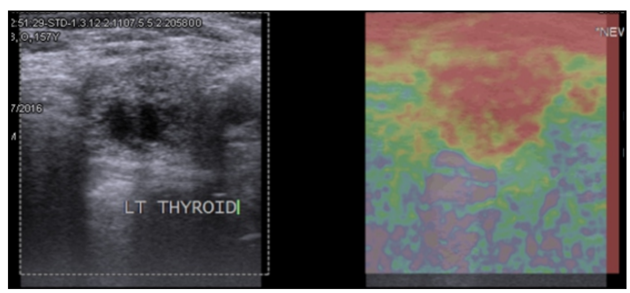

Figure-7: Score of 5 indicates no elasticity in the nodule or in the area surrounding it / showing posterior shadowing.

The present study was conducted in the Department of Radiodiagnosis , Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh in 55 patients presenting with symptoms and signs suggestive of a thyroid nodule. High resolution ultrasonography with elastography was performed in all patients. Two patients 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 1, 22 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).

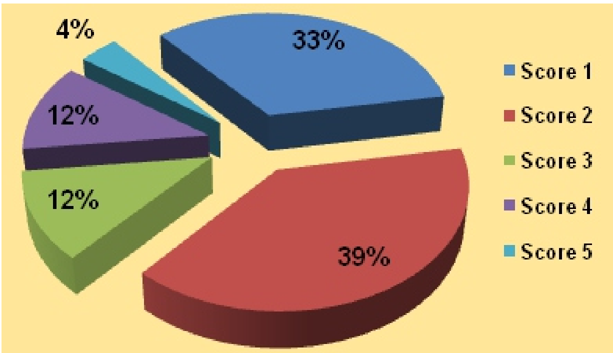

Figure-8: Elastography Scoring

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	43

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 pateints, 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 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.

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

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%.

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.

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.[7]

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 had a sensitivity and specificity of 82 % and 96% respectively in their series.[8]

Rago T et al study included 92 consecutive patients with a single thyroid nodule. Tissue stiffness on US elastography was scored from one (greatest elastic strain) 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%, a positive predictive value 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 nodules on cytology.[7]

Hong Yet al examined one hundred forty-five nodules in 90 patients by B-mode ultrasound, colordoppler ultrasound, and ultrasound elastography. The final diagnosis was obtained from histologic findings. 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%. 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.[9]

Merino S et al studied that 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. 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.[10]

Sun J et al 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.[11]

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.

REFERENCES

1. Hegedüs L. Thyroid ultrasound. Endocrinology and Metabolism Clinics of North America. 2001;30(2):339-360.
2. Wang Y, Dan H, Dan H, Li T, Hu B. Differential Diagnosis of Small Single Solid Thyroid Nodules using Real-Time Ultrasound Elastography.J Int Med Res. 2010;38(2):466-72.
3. Zhang Y, He Y, Xu H, Xu X, Liu C, Guo L et al. Virtual Touch Tissue Imaging on Acoustic Radiation Force Impulse Elastography: A New Technique for Differential Diagnosis Between Benign and Malignant Thyroid Nodules. J Ultrasound Med.;33(4):585-95.
4. Stoian D, Cornianu M: Nodular thyroid cancer. Diagnostic value of real time elastography.Chirurgia. 2012;107:39-46.
5. Kwak JY, Kim EK. Ultrasound elastography for thyroid nodules: recent advances.Ultrasonography. 2014;33:75-82.
6. 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 EndocrinolMetab. 2010 Dec;95:5274–80.
7. Rago T, Santini F et al. Elastography: New Developments in Ultrasound for Predicting Malignancy in Thyroid Nodules.J Clin Endocrinol Metab. 2007;92(8):2917-22.

8. 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.

9. 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.

10. 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 Am J Neuroradiol. 2011;32:2142–2148.

11. Sun J, Cai J, Wang X. Real-time Ultrasound Elastography for Differentiation of Benign and Malignant Thyroid Nodules: A Meta-analysis. J Ultrasound Med. 2014;33(3):495-502.