

RESEARCH ARTICLE

Role of Ultrasound Elastography for Predicting Malignancy in Suspicious Thyroid Nodules: A Prospective Study

Mohd Rashid¹, Rizwana Bano², Amit Agarwal³, Neeraj Jain⁴, Saba Retnam⁵, Gyan Chand⁵, Anjali Mishra⁵, Gaurav Agarwal⁵, S K Mishra⁶

¹Consultant Endocrine Surgeon, Lucknow, Uttar Pradesh, India

²Department of Community Medicine, Career Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

³Professor, Endocrine Surgery, Medanta Super Speciality Hospital, Lucknow, Uttar Pradesh, India

⁴Professor, Radiodiagnosis, SGPGI, Lucknow, Uttar Pradesh, India

⁵Professor, Endocrine Surgery, SGPGI, Lucknow, Uttar Pradesh, India

⁶Head of Department, Endocrine Surgery, RMLIMS, Lucknow, Uttar Pradesh, India

Received: 21st March, 2026; Revised: 18th April, 2026; Accepted: 30th April, 2026; Available Online: 04th August, 2026

ABSTRACT

Background: Accurate preoperative differentiation between benign and malignant thyroid nodules remains challenging, particularly in patients with indeterminate fine-needle aspiration cytology (FNAC). Ultrasound elastography (USE) has emerged as a promising, non-invasive diagnostic modality for assessing tissue stiffness and predicting malignancy. This prospective study evaluated the diagnostic performance of qualitative and semiquantitative ultrasound elastography in solitary thyroid nodules and assessed the feasibility of surgeon-performed elastography.

Methods: A prospective study was conducted on 135 patients with solitary thyroid nodules (1–5 cm) who underwent thyroid surgery. All patients underwent conventional ultrasonography with the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS), qualitative elastography using the Asteria colorimetric score, semiquantitative elastography using strain ratio, FNAC, and histopathological examination, which served as the reference standard. Diagnostic performance of individual and combined elastography parameters was analyzed.

Results: Histopathology confirmed malignancy in 38 (28.1%) and benign disease in 97 (71.9%) patients. The incidence of malignancy increased progressively with higher colorimetric scores and strain ratios. Qualitative elastography demonstrated a sensitivity of 80.4%, specificity of 68.0%, and accuracy of 68.6%, whereas semiquantitative elastography achieved a sensitivity of 78.9%, specificity of 84.5%, and accuracy of 84.2%. Combining both elastography techniques improved diagnostic performance, yielding a sensitivity of 73.3%, specificity of 85.5%, negative predictive value of 89.2%, and overall accuracy of 84.8%. Surgeon-performed elastography demonstrated diagnostic performance comparable to radiologist-performed examinations.

Conclusion: Ultrasound elastography is a valuable adjunctive tool for predicting malignancy in solitary thyroid nodules. Combined qualitative and semiquantitative elastography provides high diagnostic accuracy and negative predictive value, potentially reducing unnecessary diagnostic thyroid surgery, particularly in patients with indeterminate cytology.

Keywords: Thyroid nodule, Ultrasound elastography, Strain ratio, Asteria score, ACR TI-RADS, Fine-needle aspiration cytology, Thyroid malignancy.

Journal of Surgery Archives (2026); DOI: 10.21590/jsa.04.01.03

How to cite this article: Rashid M, Bano R, Agarwal A, Jain N, Retnam S, Chand G, Mishra A, Agarwal G, Mishra SK, Role of Ultrasound Elastography for Predicting Malignancy in Suspicious Thyroid Nodules: A Prospective Study. Journal of Surgery Archives. 2026;4(1):9-12.

Source of support: Nil.

INTRODUCTION

With increasing incidence of thyroid nodules, serial sonological observation of nodules has become an important modality of management.¹ The first step before offering observation is to rule out malignancy. Although fine needle aspiration cytology is considered to be the gold standard for this, in up to 15 to

30% of cases, the results of cytology are either non-diagnostic or indeterminate.² Many of these patients need diagnostic hemi-thyroidectomy, which can be avoided if malignancy can be ruled out.

To reduce the number of diagnostic hemi thyroidectomies in such cases, other modalities, including molecular analysis

*Author for Correspondence: mdrashid924@gmail.com

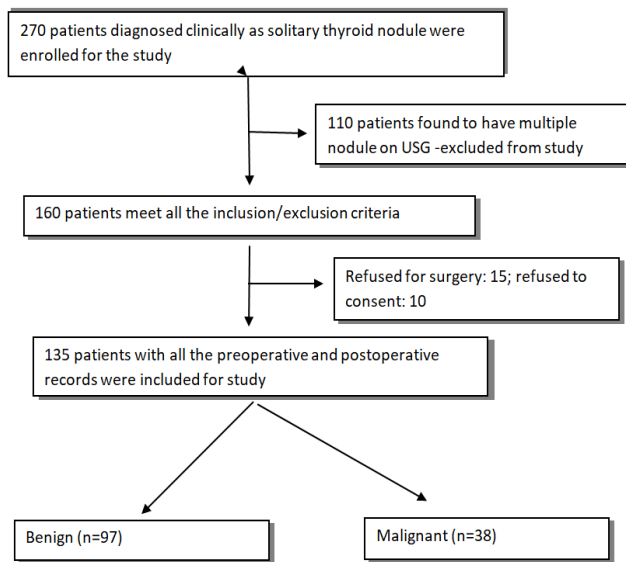


Fig 1: Consort diagram

of cytology samples, have been developed, but they are too costly and not easily available.³

Ultrasound elastography (USE) is a non-invasive modality to predict malignancy in thyroid nodules.⁴ Previous studies on USE are focused on thyroid nodules, including both solitary thyroid nodules and individual nodules of multinodular goitre and since the introduction of non-invasive follicular tumour with papillary-like nuclear features as a benign entity, the results of previous studies who has included this entity as malignant may be different.

Authors attempted to evaluate the performance of USE in a specific cohort of patients with solitary thyroid nodules, excluding the patient with multiple nodules and including NIFTP as a benign entity. At the same time author also tried to assess the accuracy of surgeon-performed ultrasound elastography.

Patients and Methods

Consecutive patients attending the outpatient department of endocrine surgery with complain of thyroid nodule has been considered. These patients underwent detailed clinical evaluation before enrolment. The flow of patients through enrolment, exclusion and final analysis is shown in Figure 1.

All patients with solitary thyroid nodules ranging from 1 to 5 cm in size were enrolled for the study. Patients with a prior history of thyroid surgery, co-morbid illnesses and features suggestive of hypothyroidism or hyperthyroidism were excluded from the study.

All enrolled patients underwent preoperative evaluation, including thyroid function test, ultrasound study of the neck (Thyroid imaging reporting and data system, TIRADS) and fine needle aspiration cytology. Patients with evidence of eggshell calcification, hyperthyroidism and purely cystic nodules were excluded from the study.

TIRADS and Ultrasound Elastography

TIRADS and USE were done on “ESAOTE my lab twice” with high frequency linear probe at 12 MHz. A probe was placed on the extended neck and after evaluation of all the sonological features, a TIRADS score was given to the nodule using American College of Radiologists (ACR) criteria. The same probe was used for ultrasound elastography to calculate the colorimetric score (Asteria criteria) and strain ratio. Qualitative elastographic patterns were categorised according to the four-point Asteria colour score, as illustrated in Figure 2.

On pressing the elastography option, two boxes appear on screen, one for the B-mode ultrasound and another for elastography. Constant repetitive pressure was applied on the nodule in a perpendicular direction till machine identified that the acquired image was appropriate for analysis by giving a green signal. This image is then viewed on the screen and the colorimetric score is noted. After this strain ratio button on the keypad is pressed and two circles pop up on the screen. One circle was placed over normal thyroid tissue (Z1) and another on our targeted area (Z2). The machine automatically calculated the strain ratio (Z2/Z1).

To assess the accuracy of surgeon-performed ultrasound elastography initial 20 cases were done by a radiologist and the surgeon was observing. In another 20 cases, elastography was done by a surgeon under the supervision of a radiologist. Rest all the cases were performed by the surgeon alone and verified by the radiologist with digital saved images.

Fine Needle Aspiration Cytology (FNAC)

FNAC was performed by a cytopathologist using a 23 G disposable needle and a 5 mL syringe by the capillary method. A maximum of 5 passes were done and aspirated material was expelled on two glass slides and immediately placed in 95% alcohol for staining. A cytopathologist examined the slide and reporting was done using the BETHESDA classification.

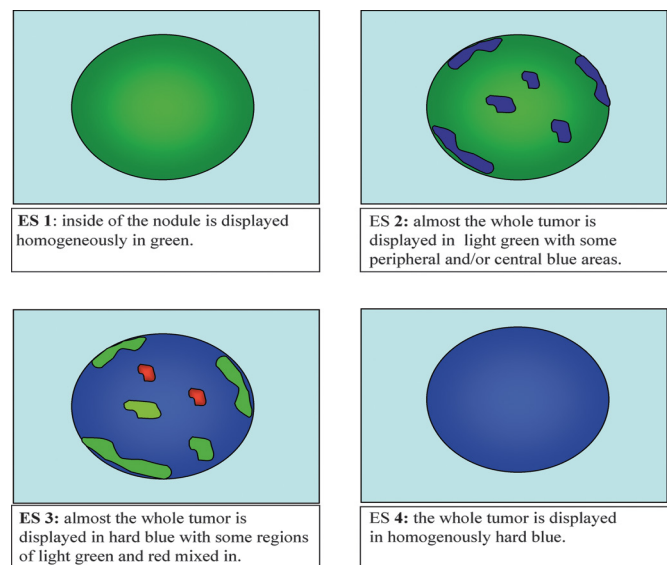


Fig 2: Asteria criteria for qualitative elastography

Table 1: Correlations with histopathology

<i>Tirads scoring</i>	<i>Benign (n=97)</i>	<i>Malignant (n=38)</i>	<i>Malignant (%)</i>	<i>Total</i>
TIRADS -2	7	0	0	7
TIRADS- 3	42	2	4.7	44
TIRADS- 4	47	31	39.7	78
TIRADS- 5	1	5	83.3	6
Colorimetric score (CS)				
1.0	16	1	5.8	17
2.0	48	7	12.7	55
3.0	27	10	27.0	37
4.0	6	20	76.9	26
Strain ratio (SR)				
1	32	1	3.1	32
2	57	1	1.7	58
3	9	36	80	45
FNAC (Bethesda)				
1	2	0		2
2	48	5		53
3	31	3		34
4	13	10		23
5	1	6		7
6	2	12		14

All surgeries were done by an endocrine surgeon and resected specimens were sent to a pathologist in formalin solution either the same day or a day after the surgery. An expert thyroid histopathologist analysed all specimens.

RESULTS

In this study, 270 patients were enrolled initially with a clinical diagnosis of solitary thyroid nodule. 110 patients were found to have two or more nodules (including sub centimetric nodule on ipsilateral/contralateral) on subsequent ultrasonography and were excluded. Of the remaining 160 patients, 25 patients refuses for surgery. A total of 135 patients meeting all the inclusion criteria were included in our study.

The median age of the patients was 36 years (range 12–67 years), with 81.0% (n=108) being female. Our study cohort included right lobe nodules, left lobe nodules, and isthmic nodules in 46.6, 42.2, and 2.7%, respectively. Median size of the nodule was 3.3 cm (range 1–5 cm).

Basic characteristics of the patients are given in Table 1.

On qualitative elastography incidence of malignancy was 5.8, 12.7, 27.0, and 76.9% in type 1, 2, 3 and 4, respectively, while on semiquantitative elastography incidence of malignancy was 3.1, 1.7 and 80% in group 1, 2 and 3, respectively.

Sensitivity, specificity, PPV, NPV and accuracy of qualitative and semiquantitative elastography were 80.4, 68.0, 47.6, 88.8, 68.6 and 78.9, 84.5, 66.6, 91 and 84.2%, respectively. On combining the two (elastography as a single modality of investigation), sensitivity, specificity, PPV, NPV and accuracy were 73.3, 85.5, 66.6, 89.2 and 84.8%, respectively. The diagnostic performance of ACR TI-RADS, colour score, strain ratio, combined elastography and FNAC is presented in Table 2.

DISCUSSION

Our study shows semiquantitative elastography (strain ratio) and qualitative elastography (colorimetric score) are sensitive and specific enough in ruling out malignancy in suspicious thyroid nodules. By combining both parameters, a sensitivity and specificity can be approached to that of fine needle aspiration cytology.

Colorimetric score of 1 and 2 predicts benign lesions satisfactorily, with malignancy only in one (5.8%) and 7 (12.7%) patients, respectively. On further evaluation, patients with a score of 1 and 4 patients of score 2 was having cytopathology reports of the indeterminate group (FLUS: 2, Follicular neoplasm: 3). This suggests that a false negative result on elastography was due to follicular histopathology. In our study, no false negative results were found in the papillary thyroid carcinoma group. Our result of qualitative elastography correlated well with that of the recently published result of Monika Garg *et al.* in 2018.⁷

A colorimetric score of 4 predicts malignancy in 76.9% and gives a false positive result in 6 patients. 4 out of 6 patients had lymphocytic thyroiditis on histopathology, suggesting that lymphocytic thyroiditis makes nodules stiff and gives a false positive result on elastography.

A similar study by Hervé Monpeyssen *et al.*⁹ suggested that USE is better in predicting malignancy in papillary thyroid cancer however, its role in predicting malignancy in follicular lesions is limited. In our study, most of the false positive and false negative results are due to follicular lesions.

Sensitivity and specificity of qualitative elastography in our study were 80.4 and 68%, respectively, which is lower than that described originally by Asteria *et al.* in 2008 (94.1% and

Table 2: Comparison of various modalities to predict malignancy

	<i>Sensitivity (%)</i>	<i>Specificity (%)</i>	<i>PPV (%)</i>	<i>NPV (%)</i>	<i>Accuracy(%)</i>
TIRADS	68.0	77.3	54.1	86.2	76.8
Colorimetric score	80.4	68.0	47.6	88.8	68.6
Strain ratio	78.9	84.5	66.6	91	84.2
Use (CS+SR)	73.3	85.56	66.6	89.2	84.8
TIRADS+USE	76	87.6	69.6	91	87.0
FNAC	85	78	38	96	78.3

81%, respectively); however, PPV, NPV and accuracy of our study correlated well with those of the study by Asteria *et al.*⁴

Semiquantitative elastography using strain ratio gives better specificity, positive and negative predictive value and accuracy than qualitative elastography, but sensitivity is lower. Combination of qualitative and semiquantitative elastography gives sensitivity, specificity, PPV, NPV and accuracy of 73.3, 85.5, 66.6, 89.2 and 84.8%, respectively which in correlation with recent study by Dhayalan *et al.*⁵ Yan-RanDu *et al.*⁶ in 2018 studied the sensitivity and study of TIRADS and elastography in combination and found a sensitivity and study of 94.44 and 87.14% respectively which is slightly higher than our study (73.3 and 85.6%, respectively) which is probably because of more no. of follicular lesion in our study.

Although the majority of study suggests that elastography has an important role in predicting malignancy in thyroid nodule but, one study published by Bo Ra Yang, MD *et al.* in 2017⁸ suggested that strain ratio and elasto score have no predictive significance on multivariate regression analysis.

Sensitivity and specificity of radiologist-performed elastography (n=40) were 76.4 and 88%, respectively, while that of surgeon-performed elastography (n=95) was 70.3 and 83%, respectively. On statistical analysis, both results were not significant ($p > .05$), suggesting that the technique of ultrasound elastography can be easily mastered by a surgeon after brief training.

REFERENCES

1. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, Pacini F, Randolph GW, Sawka AM, Schlumberger M, Schuff KG, Sherman SI, Sosa JA, Steward DL, Tuttle RM, Wartofsky L. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. *Thyroid*. 2016 Jan;26(1):1-133. doi: 10.1089/thy.2015.0020. PMID: 26462967; PMCID: PMC4739132.
2. Kim N, Lavertu P. Evaluation of a thyroid nodule. *Otolaryngol Clin North Am*. 2003 Feb;36(1):17-33. doi: 10.1016/s0030-6665(02)00130-5. PMID: 12803007.
3. Moses W, Weng J, Sansano I, Peng M, Khanafshar E, Ljung BM, Duh QY, Clark OH, Kebebew E. Molecular testing for somatic mutations improves the accuracy of thyroid fine-needle aspiration biopsy. *World J Surg*. 2010 Nov;34(11):2589-94. doi: 10.1007/s00268-010-0720-0. PMID: 20703476; PMCID: PMC2949559.
4. Asteria C, Giovanardi A, Pizzocaro A, Cozzaglio L, Morabito A, Somalvico F, Zoppo A. US-elastography in the differential diagnosis of benign and malignant thyroid nodules. *Thyroid*. 2008 May;18(5):523-31. doi: 10.1089/thy.2007.0323. PMID: 18466077.
5. DHAYALAN P, Phansalkar DS, Kiran CM, Rao H, Philip PK, Palanisamy M, Ramesh S, Koshy A. Ultrasound Elastography in Differentiating Benign and Malignant Thyroid Lesions and its Correlation with Fine Needle Aspiration Cytology or Biopsy Results. *Journal of Clinical & Diagnostic Research*. 2018 Dec 1;12(12). DOI: 10.7860/JCDR/2018/37844.12346
6. Du YR, Ji CL, Wu Y, Gu XG. Combination of ultrasound elastography with TI-RADS in the diagnosis of small thyroid nodules (≤ 10 mm): A new method to increase the diagnostic performance. *Eur J Radiol*. 2018 Dec;109:33-40. doi: 10.1016/j.ejrad.2018.10.024. Epub 2018 Oct 28. PMID: 30527309.
7. Garg M, Khandelwal D, Aggarwal V, Raja KB, Kalra S, Agarwal B, Dutta D. Ultrasound Elastography is a Useful Adjunct to Conventional Ultrasonography and Needle Aspiration in Preoperative Prediction of Malignancy in Thyroid Nodules: A Northern India Perspective. *Indian J Endocrinol Metab*. 2018 Sep-Oct;22(5):589-596. doi: 10.4103/ijem.IJEM_634_17. PMID: 30294565; PMCID: PMC6166563.
8. Yang BR, Kim EK, Moon HJ, Yoon JH, Park VY, Kwak JY. Qualitative and Semiquantitative Elastography for the Diagnosis of Intermediate Suspicious Thyroid Nodules Based on the 2015 American Thyroid Association Guidelines. *J Ultrasound Med*. 2018 Apr;37(4):1007-1014. doi: 10.1002/jum.14449. Epub 2017 Oct 16. PMID: 29044641.
9. H. Monpeyssen, J. Tramalloni, S. Poirée, O. Hélénon, J.-M. Correas. Elastography of the thyroid, *Diagnostic and Interventional Imaging*, Volume 94, Issue 5, 2013, Pages 535-544, ISSN 2211-5684, <https://doi.org/10.1016/j.diii.2013.01.023>.