# Value of Strain Ratio in the Assessment of Solitary Thyroid Nodules

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**ABSTRACT:**

**BACKGROUND:**

Ultrasound elastography (UE) is widely used in the diagnosis of thyroid diseases.

**OBJECTIVE:**

to evaluate the diagnostic utility of elastography stain ratio in the assessment of solid solitary thyroid nodules.

**PATIENTS AND METHODS:**

a cross-sectional study was conducted on 65 selected patients with solid solitary thyroid nodules discovered on Ultrasound (U/S) examination. The study was conducted in the U/S unit of medical college/ Al-Nahrain university and U/S unit of Al-Imamein Al-Kadhimein Medical city in Baghdad during the period from February 2018 to October 2019. U/S findings (size, shape and echogenicity of the nodules, presence of calcification, elastography findings and measurement of stain ratio), and histopathological results of the FNA.

**RESULTS:**

the final histopathological diagnosis of the 65 thyroid lesions revealed 46 (71%) benign and 19 (29%) malignant. Of the 19 malignant nodules; 12 were papillary carcinoma and 7 were follicular carcinoma. The mean age of the patients was 43.7 ±11.7 years (range 28 - 60) years, 50 (77%) of them were female and 15 (23%) were male, male: female ratio is 5:1. Strain ratio (SR) of Benign nodules was lower than that of malignant nodules (1.95±0.62 versus 6.11±3.4) and this difference was statistically significant (P- value <0.001. Best SR Cutoff - value was (>2.6) with a sensitivity of 100% & specificity of 86.4% (a higher value was more indicative of malignancy).

**CONCLUSION:**

SR in a good parameter to aid differentiating benign from malignant solitary thyroid nodule. SR is higher in malignant thyroid nodules.

**KEYWORDS:** strain ratio, solitary thyroid nodules.

## INTRODUCTION:

According to the American Thyroid Association (ATA), thyroid nodules are a common clinical problem[1]. Thyroid nodules are commonly found in the general population and are present in 33% of the population younger than 65 years and in 50% of the population older than 65 years [2], with a prevalence of approximately 4%–7% by palpation, on ultrasound (US), the presence of thyroid nodules is found in 27%–67% of adults; thyroid nodules at autopsy are observed in nearly 30%–60% of the population [3]. Although most nodules are benign, 5% to 15% are malignant [4, 5].

Ultrasonography is currently the major approach in the diagnosis of thyroid nodules [6].

As a simple non-invasive examination method, ultrasound has significant advantages in the diagnosis and differential diagnosis of thyroid nodules [7]. Previous studies have used US to determine the characteristics of malignant thyroid nodules, such as hypoechogenicity, microcalcification, margin irregularity, local invasion, associated regional lymphadenopathy, and increased blood flow in the nodules [8]. However, none of these US features can recognize thyroid cancer with high sensitivity and a high positive predictive value [4, 9], and thus US has a relatively low diagnostic performance in differentiating between benign and malignant nodules [10].

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In recent years, the application of ultrasound elastography and Thyroid Imaging Reporting and Data System (TI-RADS) classification criteria has further expanded the scope of ultrasound differential diagnosis between benign and malignant thyroid nodules [11-13].

Ultrasound elastography (UE) is widely used in the diagnosis of thyroid diseases with the unique advantage of understanding the hardness of tissue [14]. Several studies have shown that UE helps to improve the diagnosis of benign and malignant thyroid nodules [15, 16]. Ultrasound elastography is a noninvasive, painless imaging tool, based on the estimation of the mechanical properties (elasticity) of the tissue, that provides additional and clinically relevant information [16]. This method is based on the fact that a firm structure is associated with an increased risk of malignancy [17], on average, benign thyroid nodules are 1.7 times stiffer than the surrounding thyroid tissue, and malignant thyroid nodules are 5 times stiffer [18]. There are two main types of elastography currently in clinical use, strain elastography (SE), and shear wave elastography (SWE) [19]. Both methods can be used to assess tissue stiffness and aid in the diagnosis of thyroid nodules. It was hypothesized that the addition of elastography can increase the diagnostic performance beyond the conventional US mode [20].

The strain ratio (SR) was introduced as a numeric parameter to achieve an objective and standardized stiffness evaluation. The SR on elastography is a semiquantitative analytic method. This value compares the stiffness or strain of 2 different areas within the same image: 2 regions of interest (ROIs) are manually applied on the screen, one on the target nodule and the other either on the reference normal thyroid tissue or some other peripheral tissues. These measurements allow the SR value to be automatically calculated by the analytic software of the US machine [21].

## AIM OF THE STUDY:

The aim of this study is to evaluate the diagnostic utility of elastography stain ratio in the assessment of solid solitary thyroid nodules.

## PATIENTS AND METHODS:

This is a cross-sectional study and was conducted on 65 selected patients with solid solitary thyroid nodules discovered on conventional U/S examination. The study was carried out in US unit of Medical College/ Al-Nahrain university and in US unit of Radiology Department in Al-Imamein Al-Kadhimein Medical city in Baghdad during the period from February 2018 to October 2019. The Final histopathological diagnosis was confirmed by FNAC under ultrasound guide.

**Inclusion criteria:** Adult patient (age >18 years), with solid solitary thyroid nodule discovered on conventional U/S examination.

**Exclusion criteria:** pure or predominant cystic nodules, nodules with coarse calcifications, coexistence of thyroiditis (heterogeneous texture), hyperthyroidism on thyroid function test and patients in whole histopathology was non-conclusive of unavailable.

Ethical approval was taken from Institutional Al-Nahrain College of Medicine, an oral informed consent was taken from all patients contributing in this study.

The data were collected by special prepared questionnaire, the data include: age and sex of the patient, occupation, family history of thyroid cancer, ultrasound finding (size, shape & echogenicity of the nodules, presence of calcification, elastography findings and measurement of stain ratio), and histopathological results of the FNA.

The thyroid ultrasonic examination was carried out using Voluson-E6 Ultrasound machine (GE Healthcare, USA) with 5 to 12 MHz linear array transducer. The examination was done in the supine position with exposed neck and with slightly neck extension. Thyroid glands scanning performed at axial, sagittal and oblique planes. Different parameters were measured and recorded (The size, margin, composition, echogenicity, orientation, and the presence of calcification). Each selected thyroid nodule was classified at one of the TIRAD categories based on B- mode ultrasonic features.

Then elastography was performed during the same examination. The operator placed the probe perpendicular to the skin on the neck, then a box was highlighted which included the selected nodule and adequate surrounding normal thyroid tissue, the common carotid artery was avoided to prevent its pulsatile compressive effect. During the examination, the patient was asked to hold their breath and avoid swallowing to minimize motion artifact. Slight external compression was applied by the probe till an optimum pressure is achieved by the appearance of a green color on the indicator bar at the left upper corner of the screen. Images were showed in a split screen, with the B mode images on the left and the color scale elastography images corresponding to the gray-scale US image were on the right. For each selected nodule, the color criteria were recorded, and elastography scale determined. The ROI of the lesion was manually selected and as strain varies as a function of depth the homogenous adjacent thyroid tissue at the same depth as the lesion is used as a reference to calculate strain ratio (SR) automatically using dedicated software in the ultrasound machine. The mean value for each selected nodule was calculated (at least 3 measurements were taken & the average was recorded as the final result).

**Statistical analysis:** data were statistically computerized using Statistical Package for Social Sciences (SPSS) version 20 for windows. Descriptive statistics presented as (mean ± standard deviation) and frequencies as percentages.

Multiple contingency tables conducted and appropriate statistical tests performed Chi-square and Fisher's exact tests were used for categorical variables when appropriate. Sensitivity, specificity, accuracy and cutoff value were calculated. A level of significance (P-value) set at < 0.05.

## RESULTS:

Histopathological diagnosis of the 65 lesions included in the study revealed that 46 (71%) of them were benign and 19 (29%) were malignant. Of these 19 malignant nodules; 12 were papillary carcinoma and 7 were follicular carcinoma.

The age of our patients was ranging from (28 - 60) years with a mean of 43.7 ±11.7 years, 50 (77%) of them were female and 15 (23%) were male, male: female ratio is 5:1.

**Strain Ratio (SR):** the mean±SD of the SR of Benign nodules was 1.95±0.62 (range 0.38-3.8), while the SR of malignant nodules was 6.11±3.4 (range 3.6-12.3), this difference in SR was statistically significant (P- value <0.001), these findings were shown in table 1.

**Table (1): SR ratio of thyroid nodules for benign and malignant lesions among the patients.**

| | Benign | Malignant | P-value |
|---|---|---|---|
| **Mean±SD** | 1.95±0.62 | 6.11±3.4 | **<0.001*** |
| **Range** | 0.38-3.8 | 3.6-12.3 | |

*The result was significant at P-value<0.05.

The strain ratio represented at the ROC curve (figure 1) and the best SR Cutoff - value derived from analysis was (>2.6) with a sensitivity of 100% & specificity of 86.4% (a higher value was more indicative of malignancy, whereas values below this cut-off value suggest benignity) as demonstrated in table (2) and figure (1).

**Table (2): SR Cutoff – value to differentiate between benign and malignant thyroid nodules among the patients.**

| Area Under the Curve | | | | |
|---|---|---|---|---|
| **Area** | Std. Error | P-value | Asymptotic 95% Confidence Interval | |
| | | | Lower Bound | Upper Bound |
| **0.965** | 0.0215 | **<0.0001*** | 0.875 | 1.010 |

| Positive if Greater Than or Equal To | Sensitivity | Specificity |
|---|---|---|
| >2.4 | 100.0 | 80.67 |
| **>2.5** | **90.0** | **89.2** |
| >2.6 | 100.0 | 86.4 |
| >3.8 | 84.0 | 95.0 |
| >4.2 | 73.0 | 98.0 |

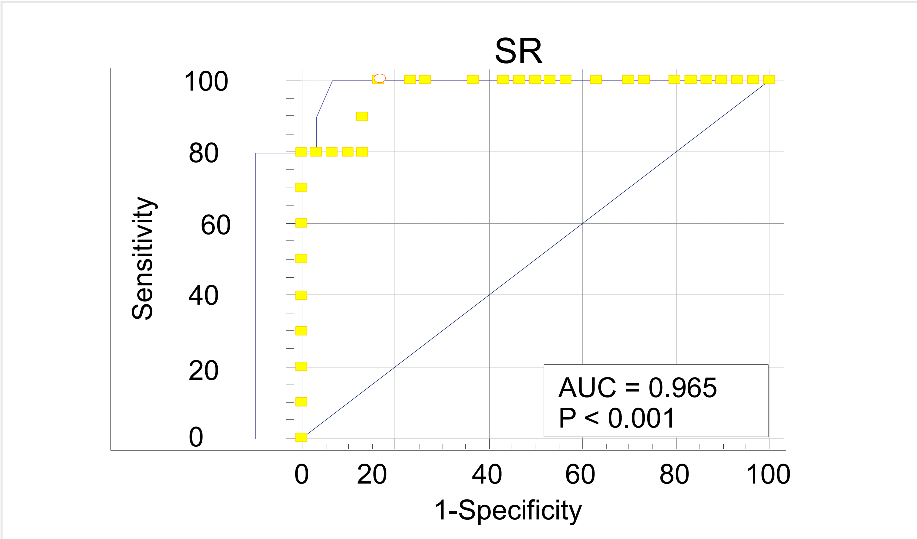


**Figure (1): The Strain ratio at ROC curve.**

## DISCUSSION:

U/S elastography described as a promising technique that developed in recent years. It assesses nodule stiffness to identify malignant from benign thyroid nodules, thus providing a new approach for differentiating malignant from benign thyroid nodules. U/S elastography can be used as a complementary tool for conventional gray-scale and Doppler US [22, 23]. Ultrasound elastography was developed to noninvasively measure tissue stiffness and strain information. Strain indicates the amount of deformation; hard tissue stretches less than soft tissue. The SR is calculated in the same image using the strain of the target lesion and the strain in the reference tissue under manual compression and tissue deformation [24]. In all form of strain elastosonography, their methods depend on the examiner. In real-time elastography, variable tissue deformation induced, depending on the compression force applied by the radiologist. Non-uniform compressions yield variability in inter- and intra-observer results [25].

The risk of malignancy of a lesion increases with the increase in the SR and decreases with the decrease in the SR [26]. In this study the optimal SR cutoff value was >2.6 and showed to have a sensitivity of 100%, a specificity of 86.4%, PPV of 68%.

The results of the current study are supported by several reported studies, Wang et al [27] suggested that elastography is a useful tool with sensitivity of 90.6%, specificity of 89.5%, and accuracy of 90.2% in thyroid nodules. Bojunga et al [28] published the results of 8 studies of 639 thyroid nodules that were examined with elastography. They reported the results for sensitivity and specificity as 92% and 90%, respectively. Xing et al [29] reported that, for the detection of malignancy, the SR measurement had sensitivity of 97.8% and specificity of 85.7%. Rago et al [30] study had reached an excellent result with the U/S elastography sensitivity, specificity, PPV, NPV and accuracy of (97%, 100%, 100% and 98%, 98.9% respectively).

Similarly, the semiquantitative elastography technique gave promising results in distinguishing the nature of thyroid nodules [31]. Fahad et al study [32] which carried out in Iraq, shows the cut-off value of 2.45 with sensitivity 100%, specificity 94.8%, PPV 80%, NPV 100%, and accuracy rate of 95.7%. Lyshchik et al [33] determined that an SR of greater than 4 was a predictor of thyroid malignancy with 96% specificity and 82% sensitivity.

In another study in which the SR for thyroid malignancy was considered to be greater than 1.5, 90% sensitivity and 50% specificity were reported [34]. In Ciledag et al study [35], SR (>2.31) predicted thyroid malignancy with a sensitivity and specificity of (86% 82%) respectively, whereas another study showed SR cutoff value of (>2) had a sensitivity and specificity of (97%, 92%) respectively [36]. Ning et al. [37] showed that SR cutoff value of (>4.2) had a sensitivity of 81% and a specificity 83%. In a meta-analysis, it was suggested that the SR is a better predictor of thyroid malignancy than other qualitative US findings [38].

However, by reviewing many studies, variable SR cut-off values were reported with "widely variable results of sensitivity (ranging from 15.7% to 98%) and specificity (ranging from 58.2% to 100%) [39]. This variation may be related to the variation in the examination techniques, and different sample size in these studies.

## CONCLUSIONS:

Strain ratio in a good parameter to aid differentiating benign from malignant solitary thyroid nodule. SR is higher in malignant thyroid nodules than the benign nodules.

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