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Grayscale ultrasound and strain elastography in the characterization of thyroid nodule in correlation with fine-needle aspiration cytology

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Abstract
Background: Thyroid nodule(s) is a common clinical problem, because of high risk of malignancy in some of these nodules it is mandatory to establish a thyroid scoring system for nodule characterization and subjecting the highly suspicious and sizable nodules to fine-needle aspiration cytology (FNAC).
Objectives: The aim of this study was to evaluate the role of thyroid imaging reporting and data system (TIRADS) and thyroid strain elastography in the assessment of thyroid nodules and correlating the results with FNAC.
Methods: This is a prospective study that includes 30 patients referred to the ultrasound unit in oncology teaching hospital, medical city, Baghdad, having anterior neck mass in thyroid gland location, during the period from the beginning of September 2018 to October 2019.
Results: The thirty patients in the study sample consists of 25 females and 5 males, most of them are in the fourth decade (43%), the majority of detected thyroid nodules are either solid, isoechoic or hyperechoic in comparison to thyroid gland and hence had 3 points and scored as TIRADS 3, this was seen in 12 patients (40%), the least detected nodules are the highly suspicious one was irregular, with microcalcification, being very hypoechoic, given score 10 and by that categorized as TIRADS 5, this seen in 4 patients (13.3%), When we correlate the TIRADS scoring, elasto scoring and elasto ratio with FNAC results we found a significant correlation between the TIRADS score and FNAC with P value of 0.012, significant correlation also seen between the elasto scan and FNAC results P-value = 0.002475, while the correlation between the elasto ratio and FNAC was not significant, P-value =0.8.
Conclusion: The TIRADS as a scoring system is an important reliable method for characterizing of thyroid nodule, the elasto score is also beneficial in evaluating the nodule when performed by professional personal, however the using of elasto ratio is not always beneficial.

Keywords: Thyroid nodule, TIRADS, strain thyroid elastography, thyroid FNAC, thyroid ultrasound

Introduction

Thyroid nodule(s) is a common finding during neck ultrasound examination in the day practice, most of those patients are asymptomatic or present with neck swelling [1], the frequency of thyroid nodule detection was further increased by increasing the level of health care and by doing frequent check-up, being about 20-76% in general population [2] and for example in Iraq the prevalence of thyroid nodules reaching to 78% in asymptomatic patients during the period from 1990-2005 [3], thyroid cancer is rare but the incidence was significantly raised reaching to 8.5% in Iraqi population [3, 4] and was about in 5% of incidentally detected thyroid nodule by ultrasound and may reach to 15% in certain literatures [5] for this reason the application of Thyroid Imaging Reporting and Data System (TIRADS) becomes mandatory for categorizing the lesions according to composition, echogenicity, shape, margin, and calcification, this system was implemented by the American college of radiologists and according to the score recorded by the individual nodule the fine needle aspiration or follow up was indicated, this is in one hand, in the other hand, the score may consider the nodule definitely benign and hence leave it alone as a final decision [6].

With the revolution happened to ultrasound technology, the introduction of elastography-shear wave and strain-may add further to TIRADS score and support the diagnosis of the benign or suspicious nodule, it provides objective evaluation of thyroid nodule stiffness [7],

in Iraq; up to this moment only strain elastography was present and thus the results in this research will be summarized according to the observations using this technique only, strain elastography results assessment is either by assessment the color scale of the thyroid node and comparing this to the standard color Bar this is called Strain elastographic scores by Asteria *et al*. which was illustrated in figure 1 below [8] or by using the second method which includes the comparison between the region of interest (ROI) in the nodule and to similar size region within the normal adjacent thyroid tissue or nearby normal neck skeletal muscle [9].

As the elastography has advantages and adds to the diagnosis of suspicious thyroid nodules, it also has limitations which is either due to the thyroid nodule itself when being coarsely calcified or cystic, this nodules gives a false impression that the nodule is rigid, the second downside is the proximity of the nodule to the carotid artery, which in turn transmits waves to the nodule gives false result about its elasticity, and never forget the effect of operator experience in manipulating the degree of pressure subjected by the probe during thyroid examination and it consequences for getting a perfect curve (10,11).

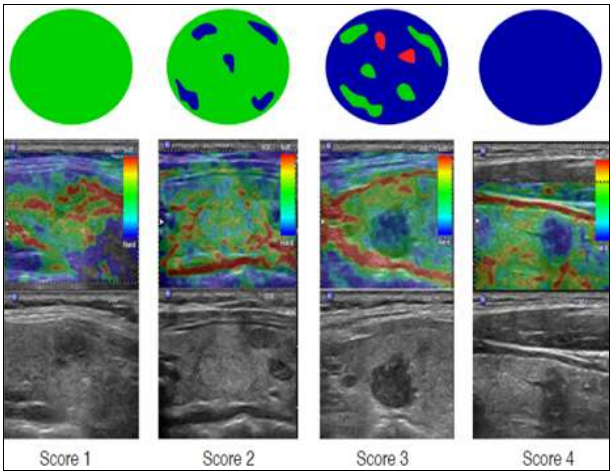

Fig 1: Strain elastography scores by Asteria *et al*. [12]

Patients and methods

This is a prospective study performed on thirty patients, presented with anterior neck lump or swelling and referred to ultrasound department after clinical examination, this was done in the oncology hospital, medical city complex, Baghdad, Iraq in the period from September 2018 to October 2019.

After clinical examination which was performed by a specialist physician; the patients were referred to radiological department to assess the nature of the neck mass, the patient name, gender, and age was recorded, the patient asked to sleep supine on the examination couch with neck fully exposed and slightly extended, the neck ultrasound scanning was performed by two radiologists using GE Voluson machine, Korea, using 6-12 MHz linear probe, the examination was performed in transverse and sagittal planes including whole neck with concentration mainly on the thyroid gland for any lesion and when the latter was detected, it size, consistency, echogenicity, and outline was recorded in addition to the presence or absence of calcification, the lesion then given a score as appoint and subsequently had a final TIRADS.

After that the detected lesion was assessed by strain elastography which was done by using the same machine utilizing elastography box which was applied to the region of interest that includes normal and abnormal thyroid tissue respectively to made the comparison regarding the tissue stiffness which gives elasticity through tissue displacement caused by external pressure, the graded compression was applied until the elasticity curve filled and green light curve appears, after that, we freezing the picture and elasticity ratio was calculated by drawing two regions of interest one in abnormal tissue and one in normal tissue and the result was calculated by the device.

Finally, the fine needle aspiration cytology was performed by a specialist pathologist under ultrasound guide from the desired lesion using 23 gauge needle and the gathered substance swiped on the slide and stained, the final result was obtained and compared with TIRADS score.

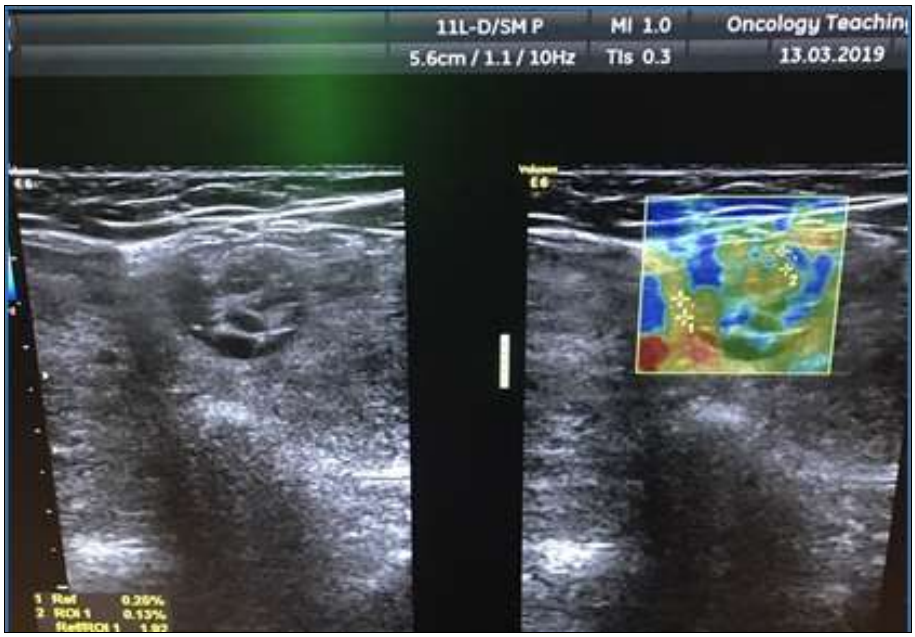

Fig 2: 35 years female with solid and cystic thyroid nodule; TIRADS 1, elastography reveals score 2 benign pattern

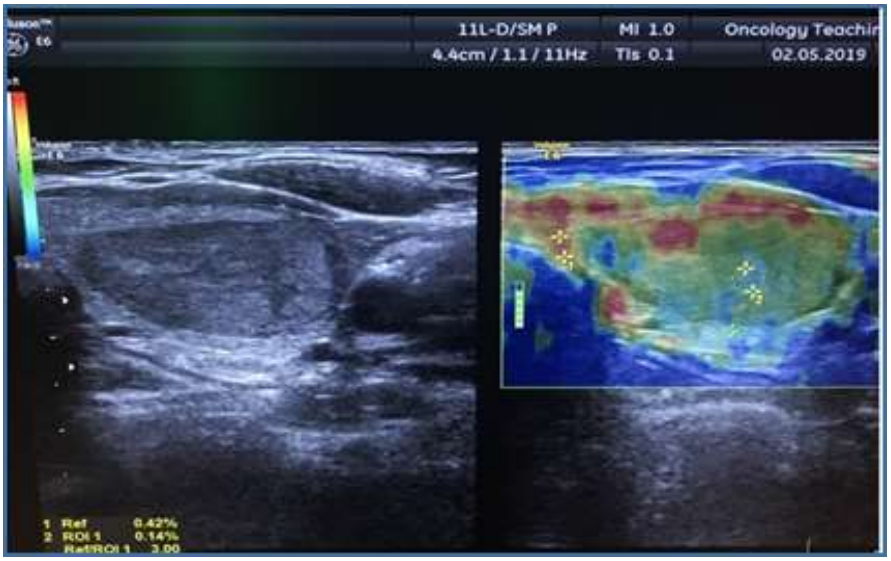

Fig 3: 29 years female with solid slightly isoechoic thyroid nodule; TIRADS 3, elastography reveals score 2 benign pattern

Results

This is a prospective study that includes 30 patients presented with a neck mass and subjected to neck ultrasound examination which reveals thyroid nodule (s). The study sample consists of 25 females and 5 males, most of them are in the fourth decades (43%), and the details of the age and gender distribution are illustrated in table 1.

Table 1: age and gender distribution of study population

Age	
Age group	Number (%)
< 30years	6 (20)
30-39	13 (43.3)
40-49	6 (20)
>= 50	5 (16.7)
Total	30 (100)
Gender	
Gender	Number (%)
Males	5 (16.7)
Females	25 (83.3)
Total	30 (100)

The majority of the detected thyroid nodules are solid, isoechoic or hyperechoic in comparison to the thyroid gland and hence had 3 points and scored as TIRADS 3, this represents 12 patients (40%), the minority of the nodules are highly suspicious being irregular, with micro calcification, very hypoechoic, hence had score 10 and by that categorized as TIRADS 5, the latter represents 4 patients (13.3%), details regarding the TIRADS scores are given in Table 2

Table 2: TIRADS scoring systems of thyroid nodules

TIRADS	**Number (%)**
1	7 (23.4)
2	0 (00)
3	12 (40)
4	7 (23.3)
5	4 (13.3)
Total	30 (100)

When we applying the elasto box to above mentioned thyroid nodules and correlating the color of the nodule that reflects the elasticity of the nodule from being soft (green to red) or hard (blue or dark blue) and this classify the nodules to four groups, we found that the majority of nodules are soft or slightly hard and hence the elasto scale was either 2 or 3, table 3 illustrate the elasto scale of the nodules.

Table 3: Elasto scale of detected thyroid nodules

Elasto scale	**Number (%)**
1	0
2	15 (50)
3	14 (46.66)
4	1 (3.34)
Total	30 (100)

Finally when we applying the elasto ratio which represents the ration of elasticity of normal thyroid tissue to that of nodule we found that the majority of the nodules had a ratio of less than 1.5 (13/30) and 12 are between 1.5-3 and; the least number is above >3

Table 4: elasto ratio for detected thyroid nodules

Age group	**Number (%)**
<1.5	13 (43.4)
1.5- 3	12 (40)
>3	5 (16.6)
Total	30 (100)

When we correlate the TIRADS score, the elasto scoring and elasto ration with FNAC results we found a significant correlation between the TIRADS score and FNAC with P value of 0.012, significant correlation was also seen between the elasto scan and FNAC results P-value = 0.002475, the last correlation was between the elasto ratio and FNAC but was not significant, P-value =0.834425

Table 5: correlation between TIRADS, elasto score, elasto ratio and FNA results

Correlations	**P-value**
TIRADS and FNAC	0.012
Elasto score and FNAC	0.002475
Elasto ratio and FNAC	0.834425

Discussion

A thyroid nodule is a common clinical problem in everyday

clinical practice, the Nodule frequency raises with increasing age, and is higher in women than men and frequently seen in population with iodine deficiency, and with radiation exposure [13].

The availability of ultrasonography devices in hospitals and outpatient clinics, in addition to that the ultrasound are inexpensive, sensitive, and lack of radiation exposure [14].

The introduction of TIRADS scoring system has a major advantage in classifying the thyroid nodules according to criteria making inter-observers bias negligible [15].

In our study, there is a significant correlation between the TIRADS and FNAC results with a P value of 0.012 and this in concordance with the study performed by Hernando Vargas-Uricoechea *et al*. in Colombia [16].

The TIRADS scoring remains the gold standard system for assessment of thyroid nodules in spite of revolution in ultrasonographic techniques including the use of strain and shear-wave elastography, this because the later has many limitations including that the well-distended cyst had low elasticity making it appears blue on elasto scan, the presence of coarse calcification within solid or partially solid nodule making the elasto scan blue due to high rigidity of calcification, finally the nodule near carotid artery shows high strain scale due to transmitted pulsation, however when the grayscale ultrasound and elastography are performed together, it will eliminate these elastography limitations [17].

The strain elastography is a growing modality that adds to TIRADS scoring in assessment of thyroid nodules either by relying on score utilized by Asteria *et al*. which seem to more informative and conclusive than using the elasto ration with P value of 0.002475 when correlating it with FNA cytology and this is in line with a study performed in Turkey by Mehmet Celal Kızılkaya [18].

The using of elasto ratio or strain ratio is misleading in our study due to variable difference in cut-off value between benign and malignant lesions in different studies some consider 1.2 [19] while other use 2.9 and 5.2 as a cut value [20], however in our study no significant correlation was seen between strain ratio and FNAC with P-value = 0.8.

Conclusion

1. TIRADS scoring system is an important reliable method of characterizing thyroid nodule and predicting follow up or intervention regarding the entitled nodule
2. Elasto score according to asteria *et al*. is also beneficial in characterizing the nodule when performed by professional personal
3. Using the elasto ratio is of limited use in characterizing the thyroid nodules.

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