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"Role Of Ultrasound And Elastography Inevaluating Nature Of Thyroid Nodules Andassessment Of Diagnostic Accuracy Of Thyroidimaging Reporting And Data System"

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ABSTRACT

Introduction:
For the detection of thyroid gland nodules ultrasound evaluations ervesas very accurate and highly sensitive method but its usefulness is very low in differentiating between benign and malignant thyroid gland tumors. Inpatient with thyroid gland nodule the efficient tool for diagnos is of thyroid cancer is fine needle aspiration although it has certain disadvantage like it is an invasive procedure and subject to sampling and analysis.

Aims and objectives: *1)To study the role of Thyroid Imaging Reporting and DataSystem (ACRTIRADS) indifferentiation of benign and malignant thyroid lesions.2)To find the association of ultrasonography findings with cytopathological reports over a period of two years at AJ Shetty hospital.3)To study the role of elastography indifferentiation of benign and malignant thyroid lesions.*

Methodology: *Prospective study was done on 119 patients with complaints of swelling in the neck, difficulty in swallowing and hoarseness of voice who were diagnosed to have solitary thyroid nodules using B mode ultrasound.*

The duration of the study was done from December 2020 to July 2022 at AJ Institute of Medical Sciences, Mangalore.

Results: *Among the 105 benign cases diagnosed by FNAC, 102 cases were diagnosed as negative by TI-RADS with 3 positive results. Similarly, out of the 14 cases diagnosed as positive by FNAC, 12 cases were diagnosed by TI-RADS with 2 false negative cases. The sensitivity, specificity, PPV and NPV of TI-RADS for detection for malignancy was 85.7%, 97.1%, 80% and 98.1% respectively. Similar results were seen for elastography. The sensitivity, specificity, PPV and NPV of TI-RADS for detection for malignancy was 85.7%, 97.1%, 80% and 98.1% respectively.*

Conclusion: *High frequency ultrasound is an ideal imaging technique for characterizing solitary thyroid nodules due to its superior anatomical resolution. Above all, it is safe because of its noninvasive nature and lack of ionizing gradiation. B-mode Ultrasound findings along with elastography correlation yields a better diagnosis. • Ultrasound elastography seems to have great potential as a new tool for differentiating solid thyroid nodules and recommending site for FNAC.*

Keywords: *Elastography, Tirads, FNAC,Thyoid*

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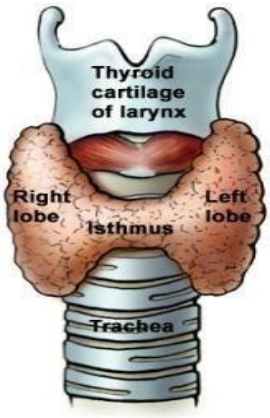
I. INTRODUCTION

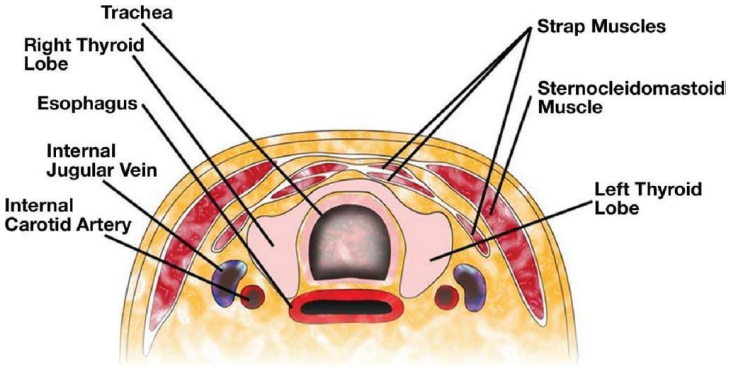
The prevalence of thyroid nodules is about 3–8% in the general population and abouthalf of thyroid nodules detected on physical examination are solitary nodules. Thepossibility of malignancy in thyroid nodule must always be considered even though chance of the lesion being benign is high. For the detection of thyroid gland tumors, the oldest and most frequently used method is palpation. Generally, about 5% of the people predominantly in the adult age group have palpable thyroid gland nodules. On palpation if the thyroid nodule is

firm and hard then the rate of malignancy of the nodule is high but as palpation is a highly subjective method the main drawback is dependent on the size and location of the nodule.

Elastography is a newly developed noninvasive imaging dynamic technique analogous to manual palpation. Under application of an external force this technique uses ultrasound to provide tissue stiffness by measuring the degree of distortion where stifft issues deform and exhibit less strain than compliant tissues in response to the sameappliedforce.Ultrasoundelastographyservesasaddedtooltostudythehardness/elasticityof nodules in differentiating benign and malignant lesions.

The aim of our study was to characterize and grade the thyroid nodules using B mode, TIRADS, Elastography and correlate with FNAC.



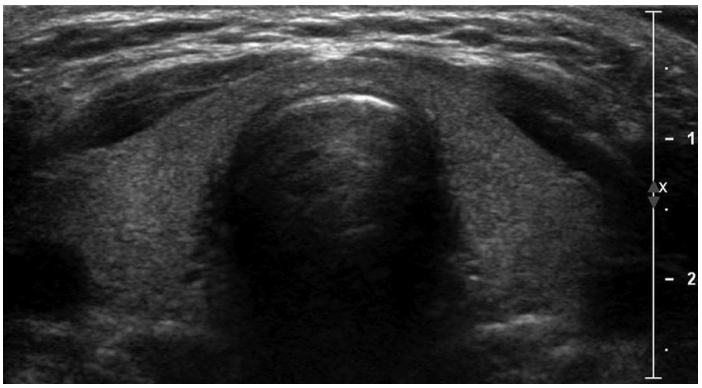


The thyroid gland lies in the visceral space extending from C5 – T1 level. It is butterfly or H-shaped bi-lobed structure which is connected anteriorly by thin rim of thyroid tissue known as the isthmus, located just below the laryngeal cartilage (Fig-1). The internal carotid arteries and internal jugular veins are located posterolateral to the thyroid lobes, whereas the strap muscles of the neck are located anteriorly

BLOOD SUPPLY

• Arterial supply to the thyroid gland is from the • Superior thyroid artery which is a branch of external carotidartery. • Inferior thyroid artery from thyrocervical trunk • Venous drainage from the thyroid gland is through superior, middle, and inferior thyroid veins. • Superior thyroid vein and middle thyroid vein drains to internaljugular vein. • Inferior thyroid vein drains to brachiocephalic vein. IMAGING APPEARANCE On ultrasound the thyroid gland appears as homogenously medium to high level echogenicity(Fig-3).7 Each thyroid lobe normally measures 4-7 cm in length,< 2cm indepth. Isthmus measures
<0.5cm indepth.

FIGURE 3: ULTRASOUND APPEARANCE OF NORMAL THYROID GLAND



II. AIM AND OBJECTIVES

1) To study the role of Thyroid Imaging Reporting and DataSystem (ACRTIRADS) indifferentiation of benign and malignant thyroid lesions.
2) To find the association of ultrasonography findings with cytopathological reports over a period of two years at AJ Shetty hospital.
3) To study the role of elastography indifferentiation of benign and malignant thyroid lesions.

III. MATERIALS AND METHODS

Prospective study was done on 119 patients with complaints of swelling in the neck, difficulty in swallowing and hoarseness of voice who were diagnosed to have solitary thyroid nodules using B mode ultrasound. The duration of the study was done from December 2020 to July 2022 at AJ Institute of Medical Sciences, Mangalore. All the 119 patients underwent Sonography, Elastography and Fine needle aspiration. The findings of B-mode and Elastography are correlated with cytology. B mode Ultrasound of the thyroid gland was performed with PHILIPS EPIQ 5G using high frequency probe 18-5MHZ with patients in supine position and extension of the neck. The lesions were categorized using Thyroid imaging reporting and data system (TIRADS) scoring system. .2

TABLE1

TIRADS1	BENIGNLESIONS
TIRADS2	NOTSUSPICIOUS
TIRADS3	MILDLYSUSPICIOUS
TIRADS4	MODERATELYSUSPICIOUS
TIRADS5	HIGHLYSUSPICIOUS

Ultrasound guided FNAC was done using 22-gauge needle and the lesion was aspirated at least twice with the freehand technique. Samples that were obtained were expelled on glass slides and they are smeared. Slides are dried and few slides are placed immediately in 95% alcohol for Papanicolaou staining.

REAL TIME ELASTOGRAPHY
1. The probe was held perpendicular to the skin with application of a steady compression towards the nodule under examination.
2. Color doppler bar confirms the appropriate amount of displacement to generate the electogram.
3. Appropriate field of view (FOV) is selected which should include the thyroid nodule under examination and the adjacent surrounding normal thyroid tissue as reference for strain ratio.
4. Strain ratio is calculated by selecting a reference region of interest (ROI) over the normal thyroid tissue and then drawing a target ROI which includes the nodule.

INCLUSION CRITERIA:
All the patients referred for ultrasound to our hospital by various departments either for palpable thyroid masses, thyromegaly or hormonal disturbances

EXCLUSION CRITERIA:
• Ultrasound examination not having HPR correlation • Patients not willing for FNAC S

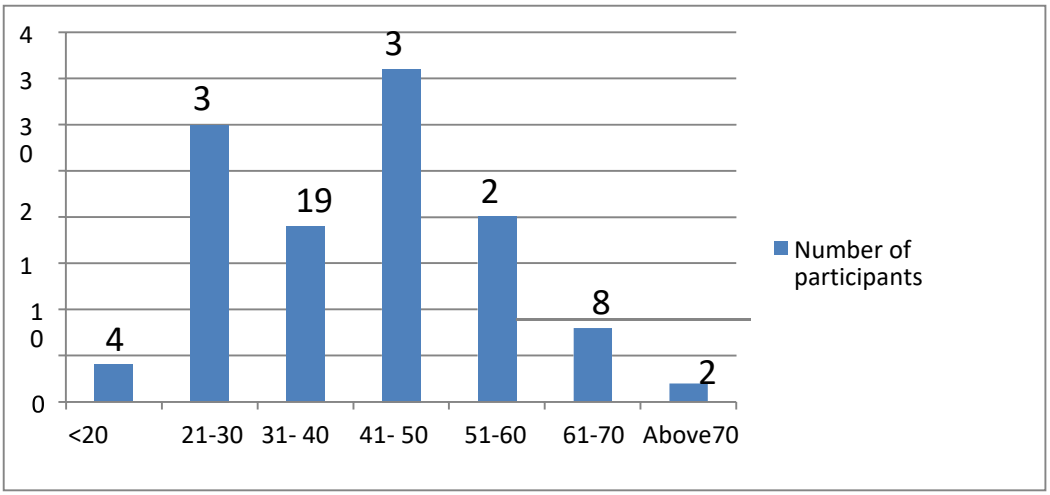
SAMPLE SIZE ESTIMATION
Source of data A two years Hospital based cross sectional study was conducted in the department of Radiodiagnosis, on the patients who meet the inclusion criteria and do not get excluded, from December 2020 to November 2022 at AJ Institute of Medical Sciences, Mangalore Method of Collection of Data Sample size :75 Based on the study assuming p =75, with the 95% confidence interval and 10% allowable error (L). We included the samples more than estiated size on order to improve the external validity of the study.

IV. RESULTS

Table No.:4 Distribution of study participants according to age

Age characteristics	Agein years
Meanage	41.6
Standarddeviation	13.54
Minimumage	14
Maximumage	81

Figure:25 Distribution of participants according to age group



The participants belonged to the age group of 14 – 81 years with mean age of 41.6 + 13.5 years. Majority of the participants belonged to the age group of 41 – 50 yrs (36, 25%), 21-30 yrs (30, 20.8%), 51-60 yrs (20, 13.9%), 31-40 yrs (19, 13.2%), 61-70 yrs (8, 5.5%), less than 20 yrs (4, 2.8%) and above 70 yrs (2, 1.4%)

Table No.5: Distribution of participants according to gender

Gender	Frequency	Percentage
Female	87	73.1
Male	32	26.9
Total	119	100

Figure 26: Pie diagram showing distribution of participants according to gender

Out of the total 119 participants, 87 (73%) were female and rest 32 (27%) were male

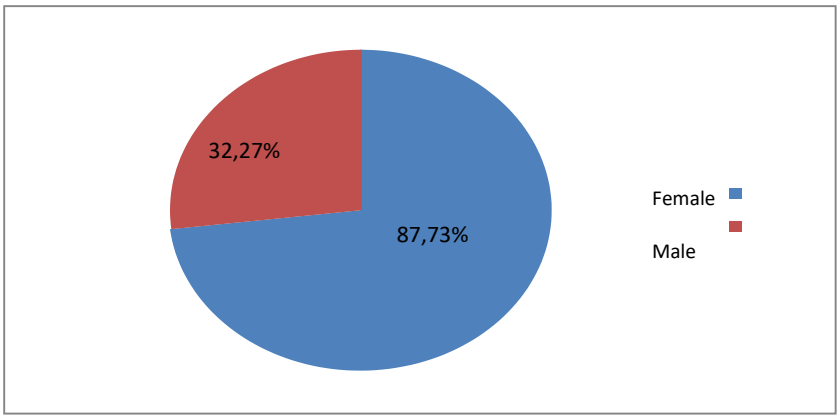


Table No.6: Distribution of participants according to clinical features

Clinical features	Freqency	Percentage
Swelling in the neck	60	50.4
Dysphagia	17	14.3
Incidental finding	3	2.5
Pain	38	26.4
Hoarseness of voice	1	0.8
Total	**119**	**100**

Figure 27: Distribution of participants according to clinical feature

The most common clinical presentation was 60 (50.4%), pain (22, 18.5%), dysphagia (17. 14.3%), pain in neck (16, 13.4%) and hoarseness of voice (1, 0.8%). Among 3(2.5%) participants, it was an incidental finding

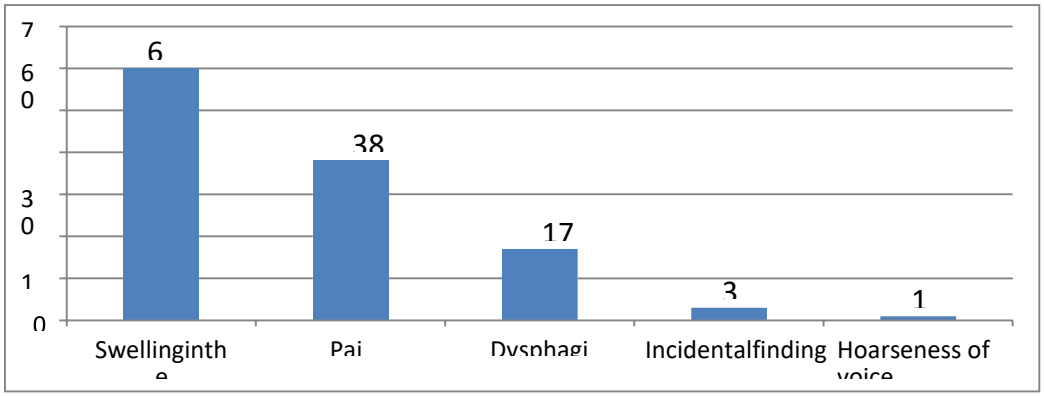


Table No.9: Distribution of cases based on elastography results

Site of swelling	Frequency	Percentage
Right	64	53.8
Left	53	44.5
Both	1	0.8
Isthmus	1	0.8

Figure 30: Pie chart showing distribution of cases based on Elastography score

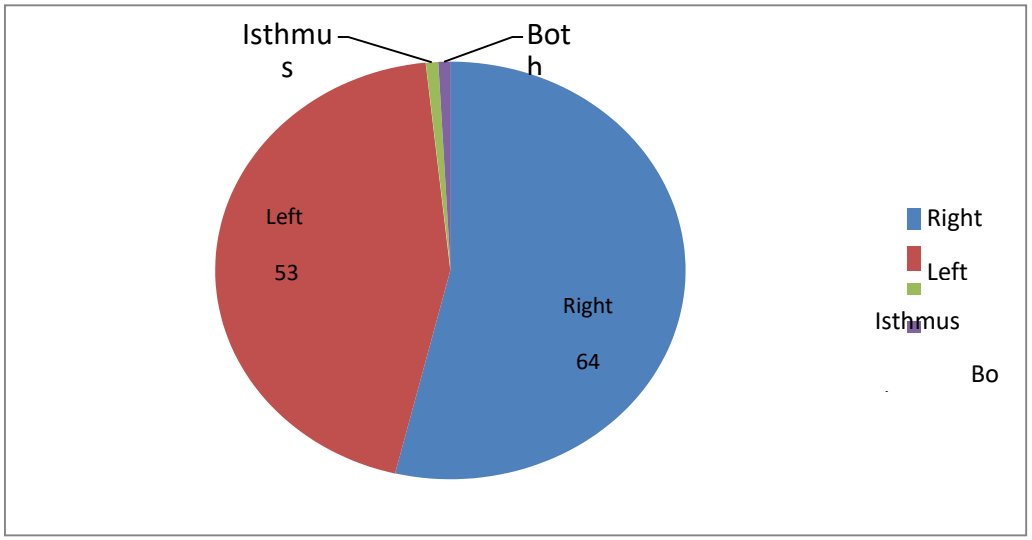


Table No.10: Distribution of participants based on FNAC results

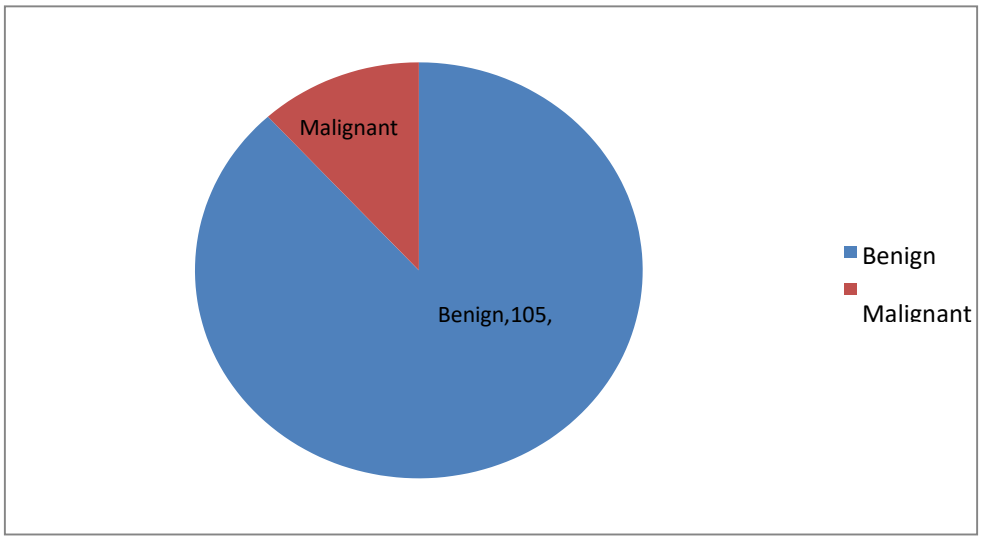
FNAC results	Frequency	Percentage
Benign follicular nodule	39	32.8
Colloid goitre	36	30.3
Hashimotos thyroiditis	7	5.9
Lymphocytic thyroiditis	6	5.0
Suspicious of malignancy	7	5.9
Papillary carcinoma of thyroid	3	2.5
Colloid goiter with secondary cystic changes	3	2.5
Adenoid nodule with focal thyroiditis	2	1.7
Granulomatous etilogy	2	1.7
Suspicious for follicular neoplasm	2	1.7
Adenoid nodule with cystic changes	1	0.8
Focal thyroiditis	1	0.8
Multinodular goitre	1	0.8
Subacute granulomatous thyroiditis	1	0.8
Suspicious of follicular neoplasm	1	0.8
Thyroid nodule with papillary architecture	1	0.8

Based on the FNAC findings, majority of the cases were benign follicular nodule (39, 32.8%) followed by colloid goitre (36, 30.3%)

Table No.:11 Distribution of cases into benign and malignant disease based on FNAC findings

FNACresult	Frequency	Percentage
Benign	105	88.2
Malignant	14	11.8
Total	**119**	**100**

Figure 31: Pie chart showing distribution of cases based on FNAC result



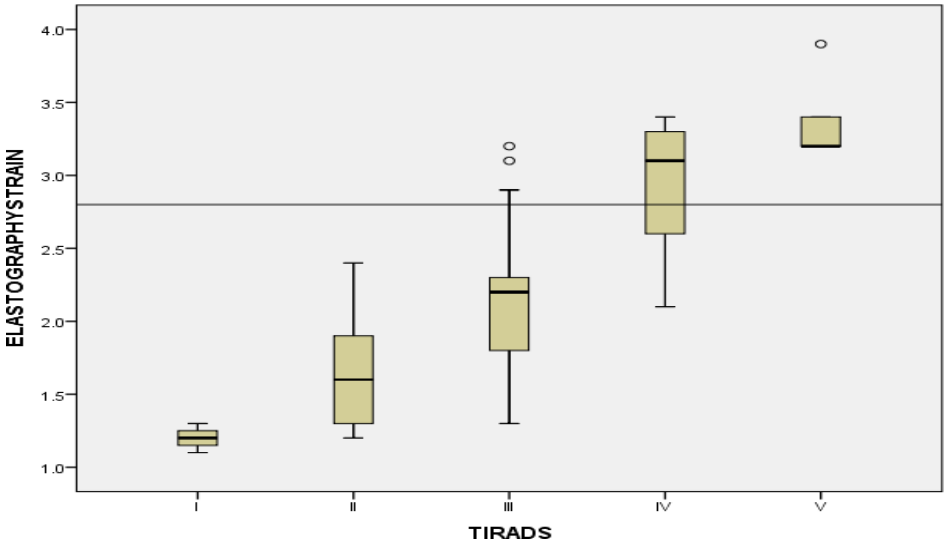
In the current study, based on the FNAC results, 105 (88.2%) participants were diagnosed as benign and the rest 14 (11.8%) were diagnosed as malignant.

Table No.12: Comparing results of TI-RADS with elastography

Elastography	TI-RADS		Total
	Benign	Malignant	
Benign	101	3	104
Malignant	3	12	15
Total	104	15	119

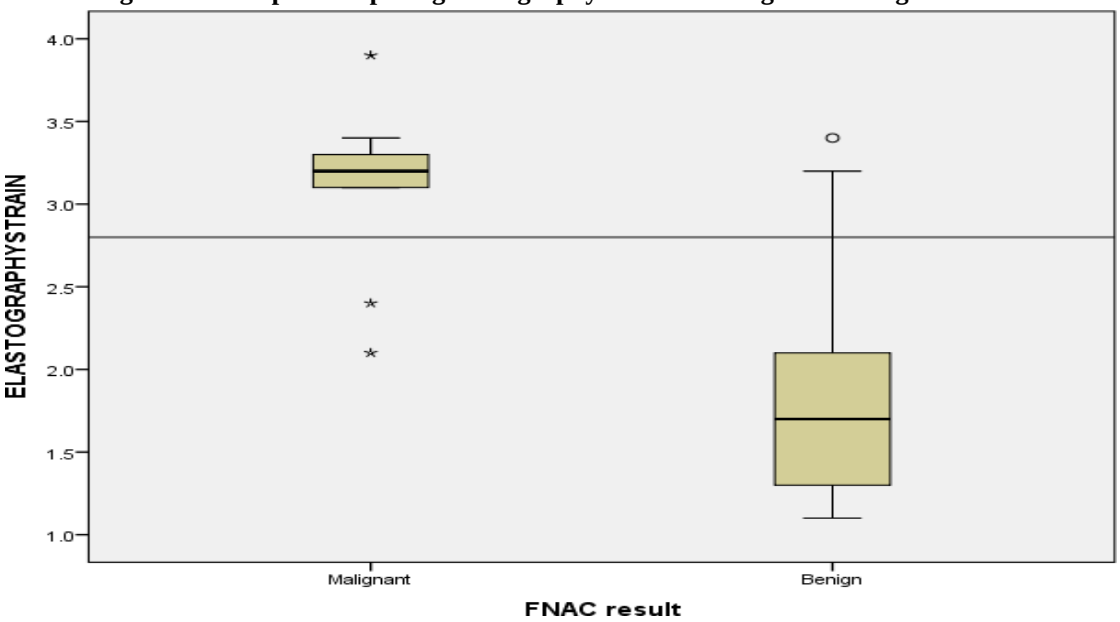
Out of the 104 cases detected as benign by TI-RADS, elastography detected 101 cases. Similarly among 15 negative cases detected by TI-RADS, elastography detected 12 cases

Figure 32: Box plot comparing elastometry with TI – RAD staging



The mean elastography value for TR 1. 2.3.4. and 5 were 1.2 + 0.8, 1.7 + 0.3, 2.1 + 0.5, 2.9 + 0.4 and 3.4 + 0.3 respectively

Figure 33: Box plot comparing elastography values of benign and malignant cases



The elastography in malignant cases ranged between 2.1 – 3.9 with mean value of 3.1 + 0.43 and the mean elastometry value for benign cases ranged between 1.1 – 3.4 with mean value of 1.8 + 0.47.

V. DISCUSSION

In our prospective study, 119 patients with thyroid swelling were evaluated with B mode ultrasonography and Elastography. The interpretation with each of the abovementioned modalities were compared with the cytological diagnosis. A majority of our cases diagnosed to have solitary thyroid nodules were females and the age group commonly affected was the 3rd to 5th decade of life. The mean age of study population for malignancy was above 50 years and for benign lesions was found to be between 30-50 Years In the study population, 105 (88.2%) lesions were benign and 14(11.8%) lesions were malignant. Out of the 14 malignant lesions, 3(2.5%) were papillary carcinoma, 3(2.5%) were suspicious for follicular neoplasm ,7(5.9%) were suspicious of malignancy ,1(0.8%) was thyroid nodule with papillary architecture. Out of the 105 benign lesions, 39(32.8%) were benign follicular nodule ,36(30.3%) were colloid goitre,7(5.9%) were Hashimotos thyroiditis,6(5%) were lymphocytic thyroiditis,3(2.5%) were colloid goitre with secondary cystic changes,2(1.7%) were adenoid nodule with focal thyroiditis,2(1.7%) granulomatous etiology,1(0.8%) focal thyroiditis,1(0.8%) multi nodular goitre,1(0.8%) subacute granulomatous thyroiditis. Following clinical evaluation of 119 patients in whom diagnosed to have solitary thyroid nodules were referred for ultrasound examination the nodule is categorized with the following features such as size, location within the thyroid gland, composition, Echogenicity, regularity of the border or margin around the nodule, presence of a halo, calcifications and they were graded according to TI-RADS scoring system Out of the 119 lesions 79 lesions (66.4%) were categorized as TIRADS 2which all the lesions turned out to be benign on FNAC so the correlation 100% for benign lesions based on TIRADS grading.

Out of the 21 lesions (17.6%) were TIRADS 3 of which 18 lesions (85%) were benign and the remaining 3 lesions (15%) were malignant. Out of the 10 lesions (8.4%) were TIRADS 4 of which 2 lesions (20%)were benign and the remaining 8 lesions (80%) were malignant. Out of the 5 lesions (4.2%) were categorized as TIRADS 5 and all these lesions turned out to be malignant on FNAC showing 100% correlation.. Thus based on the TIRADS scoring system the correlation with FNAC was 100 % for TIRADS 2 and TIRADS 5 lesions, whereas TIRADS 3 lesions were 85 % benign and 15 % malignant and in TIRADS 4 it was 20 % benign and 80 % malignant condition. According to the study done by B. Raghavan et al (32) the correlation of the benign lesions were 99.2% in TIRADS 2 and 100% in TIRADS 3 category, the correlation of the lesion being malignant was 100% in TIRADS 4 category and 91% in TIRADS 5. But in our study we found that the correlation rate was 100% in TIRADS 2 andTIRADS5 category which was significantly high. The calculation of strain ratio was done between nodule and surrounding normal thyroid parenchyma at the same depth . In the present study , Strain value of >2.8 was considered as malignant based on analysis done using ROC. According to this 14 cases were deemed as malignant. Of which 12 were only actually proven as malignant on histopathology. Out of 105 cases deemed as benign according to strain ratio,102 cases turned out to be benign and 3 cases were malignant on histopathology. According to the study conducted by Mona A. EL-Hariri et al(31) they found that Fifty-four of the 84 nodules had scores of 1 and 2, and 50 of these nodules were diagnosed histopathologically as benign. Thirty of the 84 nodules had a score of 3 and 4, and 21 of these nodules were diagnosed histopathologically as malignant. The scores of1 and 2 with Itoh criteria were significantly seen in benign nodules, whereas, scores of 3 and 4 were significantly seen in malignant nodules($p<0.05$) with sensitivity 84%, specificity 84.7%, PPV 70%, NPV 92.6% and accuracy 84.5%.

Using Rago's criteria the reasearchers calculated 97% as sensitivity as 100 %specificity for predicting malignancy in a study that was done with single thyroid nodule in 92 consecutive patients .Using Asteria's criteria, the researchers calculated 94 % as sensitivity and 81% as specificity in 86 nodules. These two investigators found the diagnostic performance of ultrasound feature on grey scale individually. The main drawback was they did not evaluate combinations of ultrasound features with elastography. Thus, in our study Elastography has a sensitivity of 85.7% and specificity of 97.1%, positive predictive value of 97.1% and negative predictive value of 80%. when compared to the study conducted by the Asteria et al 3 it is found that our study has increased specificity even though sensitivity is less.

VI. CONCLUSION

High frequency ultrasound is an ideal imaging technique for characterizing solitary thyroid nodules due to its superior anatomical resolution. Above all, it is safe because of its non invasive nature and lack of ionizing radiation. • B-mode Ultrasound findings along with elastography correlation yields a better diagnosis. • Ultrasound elastography seems to have great potential as a new tool for differentiating solid thyroid nodules and recommending site for FNAC.

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