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Role of Arfi in the Evaluation of Benign and Malignant Thyroidlesions

S.M. MohideenFathima, C.Ravindran*

Department of Radio diagnosis, Sree Balaji Medical College & Hospital Affiliated to Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

Corresponding author e-mail id: ravindran.c@bharathuniv.ac.in

ABSTRACT

To assess whether acoustic radiation force impulse imaging can differentiate normal from pathological thyroid parenchyma and to evaluate whether it can differentiate malignant from benign thyroid nodules using the ultrasound guided FNA as the gold standard. In general, ARFI elastography seems to be a good method for differentiation between benign and malignant thyroid nodules.

Keywords:malignant,ultrasound, elastography and thyroid nodules

1. INTRODUCTION

In the morphological evaluation of thyroid disorders, ultrasound has proved to be an excellent investigative tool because of the high resolution of the superficial ultrasound probes and absence of overlapping structures. The excellent depiction of anatomy has made detection of lesions fast and simple providing a targeted approach to diagnostic and therapeutic interventions. Imaging of thyroid includes several modalities like Ultrasound (USG), Computed Tomography (CT), magnetic resonance Imaging (MRI) and Nuclear scans.Initially sonography of the neck was used to differentiate solid and cystic thyroid nodules. Thyroid sonography has greatly improved from oscilloscopic deflections in A-mode, low-resolution B-mode scans to the modern era of high resolution real time gray scale high density images[1]. Currently, sonography can detect clinically occult thyroid nodules which are not apparent on physical examination or other imaging technique.High frequency sonography is the gold standard in depicting the anatomy due to several factors: [2-4]ARFI elastography is a relatively new technique that can be used for evaluation of tissue and lesions based on physical properties such as strain and shear wave to determine the hardness of the tissue. Manystudieshave been done to evaluate the benefits and possible clinical

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significance of ARFI in evaluation of thyroid, breast and other organs.Until recently ARFI was largely a research method used by a few select instituitions that had the specialized equipment needed to perform the studies. However, increasing numbers of mainstream manufacturers have incorporated elastography to their ultrasound systems and made it possible for clinical application of this technology.[5-8]

Medical use of ARFI elastography comprises focal mass evaluation for breast, thyroid, prostate, lymph nodes and in evaluating diffuse organ structure or dysfunction and possible tissue rejection in liver and kidney transplantation. New emerging exciting fields of application include arterial wall stiffness, plaque stability evaluation and cervical stiffness follow up for impending delivery in pregnancy and in monitoring ablated area during tumor therapy. [9-11]This study will correlate ARFI findings in thyroid nodule evaluation and the final cytological results, thereby to increase the confidence level of the ultrasound operator in differentiating benign from malignant lesion and thus leading to early, quick and reliable outcomes in nodular disease of the thyroid.

To assess whether acoustic radiation force impulse imaging can differentiate normal from pathological thyroid parenchyma and to evaluate whether it can differentiate malignant from benign thyroid nodules using the ultrasound guided FNA as the gold standard. Ascertain technical parameters for normal and pathological thyroid stiffness evaluation using ARFI.To derive sensitivity and specificity, positive and negative predictive values of ARFI in identifying benign and malignant nodules in thyroid.[12,13]

2. MATERIALS ANDMETHODS

Study Population:50 patients.

Subjects of The Study: All Patients with thyroid lesions-both solid and cystic.

Inclusion Criteria

Patient attending surgery department with solitary or multiple thyroid lesions or suspicion of thyroid disease were included.

Exclusion Criteria

Patients with prior biopsy proved benign or malignant lesions

Materials and Methods

Methods used for data collectionin this prospective study, patients having thyroid pathology were assessed with conventional B mode USG followed by ARFI elastography.Study was done using SIEMENS ACUSON S 2000 ultrasound system, Siemens Medical Solutions, Mountain view, CA, USA

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All the patients were subjected to B- mode and ARFI elastography using shear wave with virtual touch imaging and virtual touch quantification and the obtained data were analyzed for the sensitivity, specificity, positive and negative predictive values.

ARFI Elastography

ARFI elastography images were obtained after evaluating the nodules with conventional B-Mode US using the same probe and by the same operator. ARFI elastography included virtual touch tissue quantification (VTQ) and virtual touch tissue imaging (VTI). The patient was asked to hold the breath when the VTI and VTQ mode was initiated. The probe was placed gently on the body surface with light pressure to the thyroid.

I. VTI ElastographyImaging

VTI of ARFI was then carried out firstly. The VTI image reflects the elasticity of tissue with gray-scale image in the field of view (FOV), in which the dark indicates hard tissue whereas the bright indicates soft tissue.

II. VTQ ElastographyImaging

After the VTI imaging, VTQ was performed. VTQ can reflect the elasticity of tissue quantitatively with the shear wave velocity (SWV). The ROI was placed on the solid portion of the nodule.

III. US guided FNAcytology

Consent taken before procedure and FNA was performed under aseptic precaution under ultrasound guidance.FNAC technique was performed with free hand technology. A 22 gauge needle and 5 ml syringe were used to acquire the sample.It was performed under USG guidance using parallel technique.(26-27)

3. RESULTS

All the patients were subjected to B- mode and elastography using shear wave with virtual touch imaging and virtual touch quantification and the obtained data were analyzed using the statistical package for age, sex distribution and sensitivity, specificity, positive and negative predictive values for VTI and VTQ. The average SWV for benign lesions was 2.5 m/s, which was significantly lower than that for malignant lesions (mean SWV: 7.39m/s). To calculate the sensitivity and specificity of elastography, lesions with VTI scores 1–3 were classified as benign, while those with scores of 4 or above were classified as malignant. The statistical significant value was at $p < 0.05$.There were a total of 50 patients included in our study, out of

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these we had 11 patients who had malignant nodules and 39 who had benign nodules. The benign lesions consisted of nodular goiter, colloid goiter, hashimotos thyroiditis while malignant lesions included 10papillary carcinoma and 1 follicular carcinoma.

Fig 1: AGE DISTRIBUTION

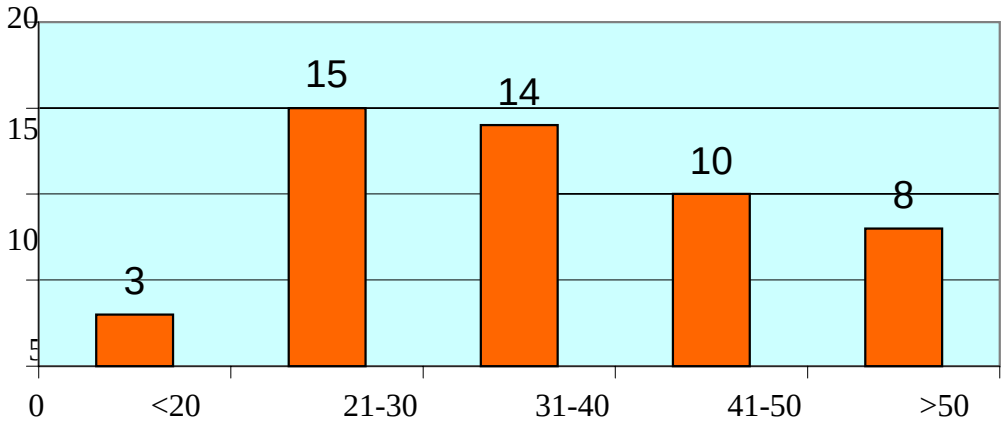
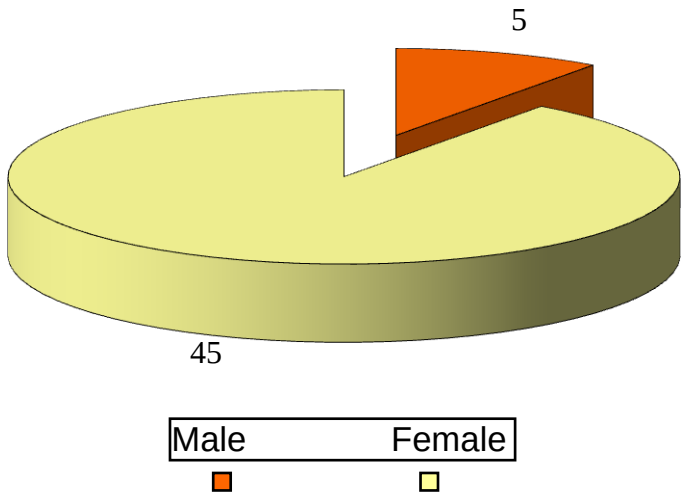


Fig 2: SEX DISTRIBUTION



The study consisted of 45 female patients (90 %)& 5 male patients(10%)

This study demonstrates the prevalence of thyroid nodular disease in the female population.

Table 1: VTI benign and malignant counts

VTI	No. ofCases	BENIGN	MALIGNANT
1 - 3	39	38	1

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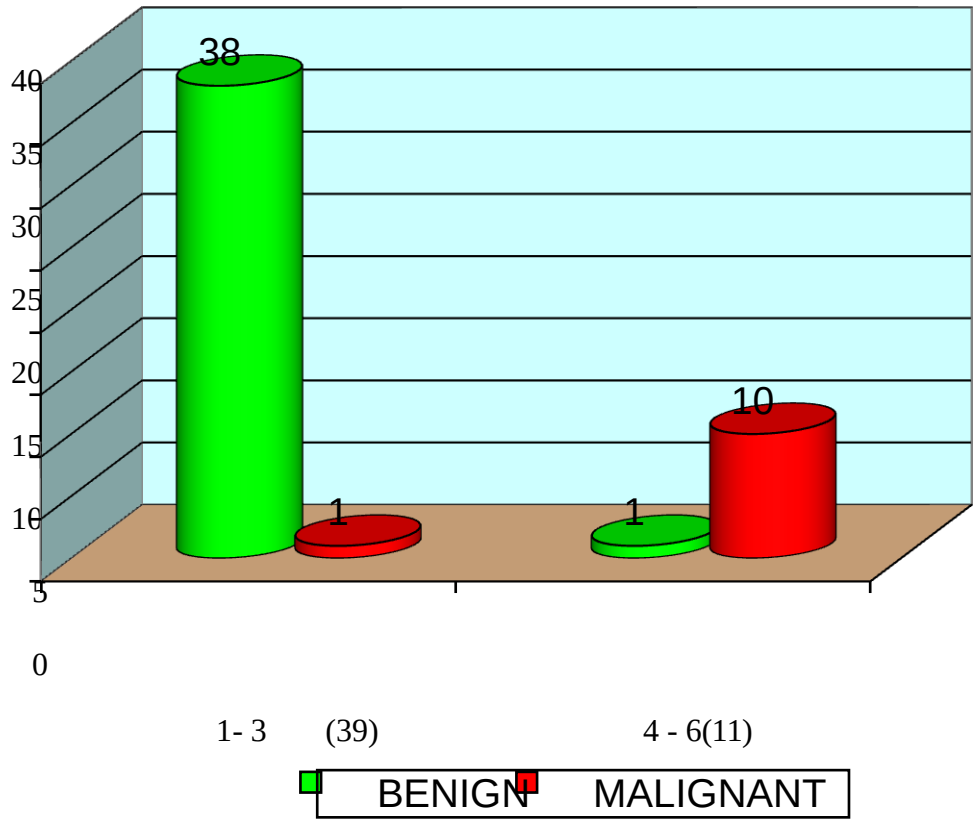
4 - 6	11	1	10
Total	50	39	11

TABLE 2: Number of cases for benign and malignant nodules by VTQ

Nodule 1VTQ	No. ofCases	BENIGN	MALIGNANT
≤2.5	37		0
> 2.5	13	2	11
Total	50	2	11

Fig 4: VTIDETERMINE FOR BENIGN AND MALIGNANT



This figureshows that the majority of the VTI of benign lesions in our study population were in the range of 1-3. The

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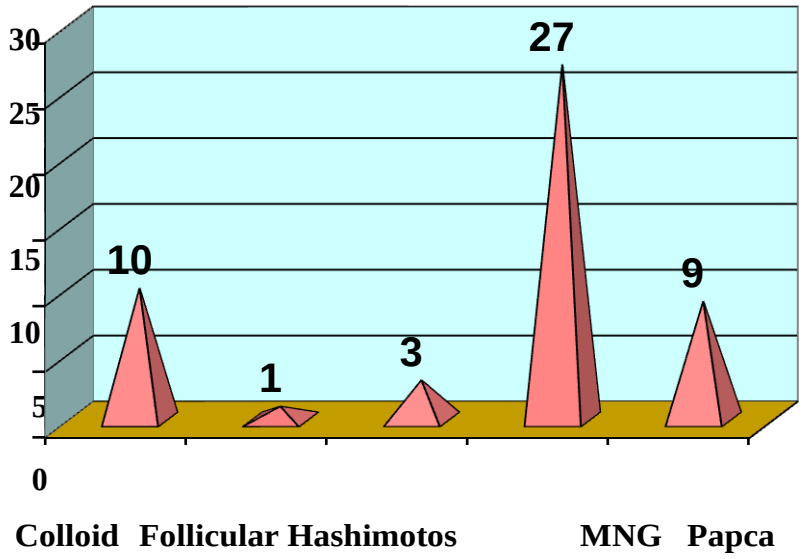
malignant nodules were in the range of 4 -6.We used the Xu's gradingsystem.

Table 3: Shows theVTQ differentiate benign and malignant

Nodule 1 VTQ	BENIGN	MALIGNANT
≤ 2.5 (37)	37	0
> 2.5 (13)	2	11

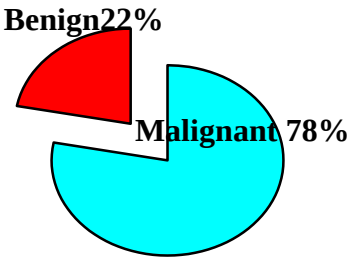
This bar chart shows that when a VTQ of less than 2.5 was taken there were 39 cases as benign and when more than 2.5 was taken,there were 2 benign and 11 malignant cases.

Fig 5: FNAC DISTRIBUTION



Bar chart distribution based on FNA report shows that nodular goiter was the most common condition in our study population followed by colloid goiter then Hashimotos. Papillary carcinoma is the most common malignant condition followed by follicular type.

Fig 6: CASES DISTRIBUTION (BENIGN / MALIGNANT)



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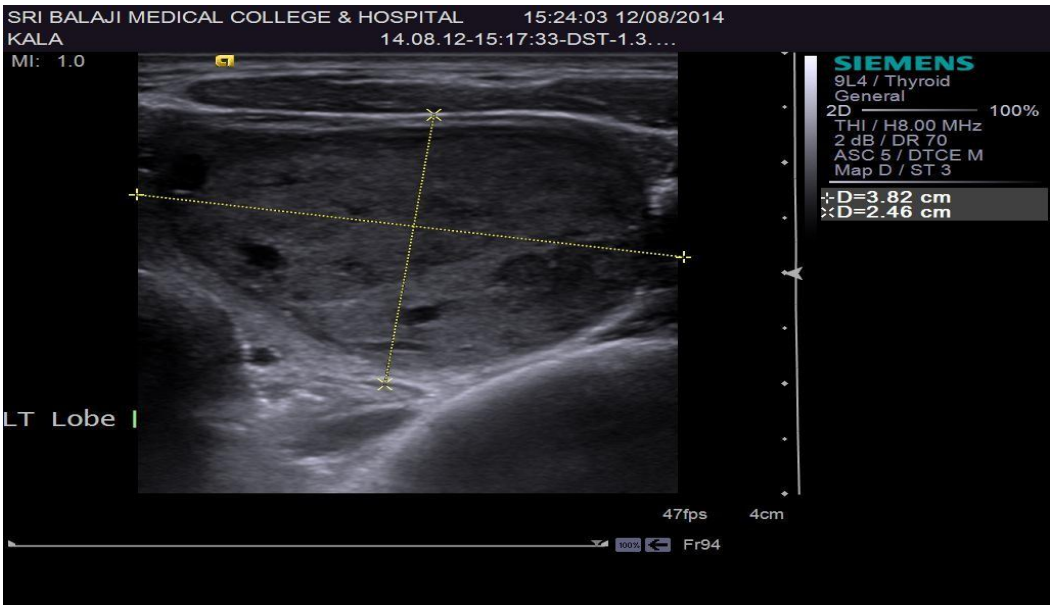
This image shows the distribution of benign and malignant thyroid nodules in our study population. Majority of the nodules were benign consisting of 78 % of the cases while the remaining 22% were malignant.

Fig 7: . Shows multiple cystic areas with central hyperechogenecity indicating it to probable colloidgoiter. FNA also proved it as colloid goiter.



4. DISCUSSION

The mean SWV ± SD on ARFI imaging in healthy, nodule-free thyroid glands was 1.906 ± 0.51 m/s . The mean SWV in benign thyroid nodules was 2.5 ± 0.55 m/s (range, 1.2–2.80 m/s), and the mean SWV in malignant nodules was 7.39 ± 1.15 m/s (range, 6.3–8.0 m/s).The sensitivity and specificity of VTQ were 100% and 84.6 %, respectively. The sensitivity and specificity of VTI was 90.9 and 97.4 % respectively. We found that SWVs were substantially higher in malignant nodules than benign ones.[14,15] Perhaps if ARFI imaging is used in conjunction with sonographic findings and patient demographics, it will be possible to find a combination of factors that would yield a negative predictive value high enough to distinguish benign from malignant nodules with confidence, which may lead to a decrease in the biopsy rate for benign nodules.Our study is limited by the fact that the sample size was relatively small. Larger studies including multiple observers would be favorable.[16]

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The size of region of interest (ROI) is fixed so very small lesions could not be assessed separately. The main limitation of this study is that ARFI VTQ is a relatively new technology. Therefore, limited data is available about the impact of the tumor size, the optimal measurement point within the lesion, the influence of the density of the surrounding tissue or the distance from the skin on the measurement, and the variance of SWV when repeatedly measuring the same region.[17,18]

The method of ARFI VTQ is technically not fully developed, as measurements above 8.0 m/s (in Siemens Acuson 2000) cannot be performed.Therefore, our results concerning mean SWV are impaired by this limitation, and replacing X.XX m/s with 8.0 m/s gives only a rough approximation of the actual SWV, although this approach has been reported before.Very large lesions could not be included in VTI which is also considered as a limitation

CONCLUSION

Thyroid elastography is now an adjunct tool in thyroid ultrasonography. It is easily performed in clinical practice, adding only a small amount of time to a normal B mode ultrasound.Sonoelastography with strain imaging, to some extent is operator dependent, as it is based on image interpretation.The technique of ARFI VTQ may have the potential to overcome this limitation, as it provides independent measurements of physical tissue properties.Shear wave elastography with quantification helps to characterize solid thyroid lesions more accurately They are accurate and reproducible but they should always be integrated with US examination .

ARFI VTQ is a feasible method that indicates malignant tissue with an elevated SWV or even, a SWV that exceeds the upper limit of possible measurement. In summary, our study demonstrated that ARFI VTQ is able to differentiate between benign and malignant nodules, by obtaining a SWV.Malignant thyroid tumors demonstrate a significantly higher rate of measurements that return a result of X.XX m/s, indicating a SWV of 8 m/ s, compared with benign tumors.Therefore, ARFI VTQ should not be used as a single test but may be helpful as an adjunct to conventional B - mode ultrasound. For this purpose, we propose the event of a highly elevated SWV as a significant criterion for malignancy.In general, ARFI elastography seems to be a good method for differentiation between benign and malignant thyroid nodules.

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Ethical approval: The study was approved by theInstitutional Ethics Committee

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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