Diagnostic Validity Of TIRADS Scoring And The Ultrasonography Criteria Used In TIRADS System In Neoplastic Thyroid Lesions

[1]Emilda Reshma, [2]Renjini S, [3]Josey Verghese, [4]Suma Job

[1]Senior Resident, [2]Assistant Professor, [3,4]Professor
[1,2,3,4]Department of Radiodiagnosis,
Govt. TD Medical College, Alappuzha, Kerala, India

Abstract— To evaluate thyroid nodules using TIRADS classification, by correlating with FNAC and to assess the diagnostic validity of individual component criteria used in the TIRADS classification system, five sonological features were assessed namely internal composition, echogenicity, margins, presence and type of calcification, and shape of the lesion. The diagnostic performance of the TIRADS classification system was evaluated by comparison with the fine-needle aspiration cytology (FNAC) reports. All follicular neoplasms on FNAC were further followed up with excision biopsy and histology. The cytopathological report was used as the standard final diagnosis for comparison and the findings analyzed with respect to histopathological findings as gold standard. Solid composition, irregular micro lobulated margins, hypoechogenicity, marked hypo echogenicity, presence of micro calcifications, taller than wider shape were associated with a higher chance of malignancy. Therefore by correctly assessing a thyroid nodule and using TIRADS score, we can confidently determine the chance of it being a malignant nodule and thus further management can be done according to it. Thus performing unnecessary FNAC / biopsy on a benign nodule can be avoided with higher degree of accuracy.

Index Terms— thyroid nodule, TIRADS, malignant thyroid nodule

I. INTRODUCTION

Thyroid scanning is one of the frequent requests which we encounter as radiologists in the ultrasound department, because of its easy availability, cheap cost and lack of radiation risks. The widespread use of ultrasonography (US) has also contributed to the increased detection of thyroid nodules. Thyroid US depicts nodules in up to 67% of the population [1]. However, less than 10% of these nodules are malignant [2,3]. When patients were assessed by ultrasound, the prevalence of a thyroid nodule was as high as 80% among children in iodine-deficient parts of India [4]. However, the incidence of thyroid cancer is low (1-1.8 per 100,000)[5].

Although fine needle aspiration cytology (FNAC) is the standard method for evaluation of thyroid nodules, it is painful, incurs health care costs, and contains the risk of infection and bruising. Approximately 10–20% of fine-needle aspiration biopsies are nondiagnostic, in which the thyroid nodule shows a high probability of malignancy, and aspiration needs to be repeated [6]. Approximately only 3–7% of thyroid FNACs have conclusive features of malignancy [7]. Hence, there is a growing imperative need to devise and follow a reliable ultrasound classification for the evaluation of the thyroid lesions and differentiating between a benign and malignant lesion with a fair element of confidence, thereby reducing the number of unnecessary invasive biopsies.

There are well-established ultrasound findings that differentiate benign and malignant thyroid nodules. It is still difficult to decide which lesions should undergo FNAC because the same thyroid nodule may be classified in different ways with different guidelines [2,8,9].Therefore, it may be confusing to determine which guideline to use when deciding whether to perform FNAC in a thyroid nodule. Of the many classification systems that have been described, Thyroid Imaging Reporting and Data System (TIRADS) described by Kwak et al. [10] is a relatively simple system which can be easily adopted, just like Breast Imaging-Reporting and Data System (BIRADS) which has been successfully used for several years to assess breast lesions. In this study we have aimed at assessing the positive predictive value (PPV) of TIRADS for the ultrasound features of thyroid nodules as described by Kwak et al [10] and its correlation with FNAC results.

II. OBJECTIVES

The primary objective was to evaluate thyroid nodules using TIRADS classification, by correlating with FNAC. The secondary objectives were 1)to assess the diagnostic validity of individual component criteria used in the TIRADS classification system and 2) to determine the positive predictive value of TIRADS

III. MATERIALS AND METHODS

This was a descriptive Study with diagnostic test evaluation.

Patients referred for thyroid scanning after applying the inclusion and exclusion criteria were selected. Inclusion criteria: Patients with solitary thyroid nodule and dominant/suspicious nodule of a multinodular goitre. Exclusion criteria: 1.Patients with grossly deranged bleeding/coagulation profile unsuitable for FNAC/biopsy. 2.Patients without FNAC/histopathological results were excluded from the study. 3.Cases with non-diagnostic or indeterminate cytology results were also excluded from our study.

Patients were included for final analysis only if they have histopathologic exam results as given by FNAC or biopsy. In cases where thyroid surgery is performed, results were followed up with histopathology report.

PROCEDURE

After our institutional ethics committee approval, a written informed consent was obtained from all patients undergoing ultrasonogram in the department. A pretested semi structured proforma was used for data collection. USG of thyroid was done using GE VOLUSON E-8 machine.

All the ultrasound scans were performed with a high frequency linear array transducer. Both lobes of the thyroid gland including the isthmus were evaluated. With the patient supine and neck hyper-extended, the entire gland was examined. Hyperextension of the neck was obtained by placing a pad under the shoulders. The neck was scanned in sagittal, transverse, and oblique sections to optimally visualize both lobes of thyroid and isthmus. Imaging of the lower poles of thyroid was done by making the patient swallow.

The internal component of the suspected lesion was categorized as solid, cystic (anechoic) and mixed (partially solid with cystic component). A solid lesion was confirmed on grey-scale ultrasound when it shows no posterior acoustic enhancement on decreasing the ultrasound gain to a minimum and when there is any amount of detectable vascularity on colour doppler imaging. The lesion was classified as cystic when completely anechoic and displays obvious posterior acoustic enhancement on decreasing the ultrasound gain to a minimum. The mixed lesions reveal features of both solid and cystic components.

Echogenicity was classified as hyperechogenicity (echogenicity of the nodule more than that of the adjacent thyroid parenchyma), isoechogenicity (echogenicity of the nodule similar to that of the adjacent thyroid parenchyma), hypoechogenicity (echogenicity less than that of the adjacent thyroid parenchyma but more than that of the surrounding strap muscle), or marked hypoechogenicity (echogenicity less than that of the surrounding strap muscle).

The margins were classified as irregular – clearly demarcated but spiculated or microlobulated margins, ill defined- interface between the lesion and the adjacent thyroid parenchyma was indistinct, ill-defined, and not smooth- greater than 50% of the border should be ill defined and regular -smooth, distinct, well-defined, and regular outline.

Calcifications when present was categorized as microcalcifications (when equal to or <1 mm in diameter and visualized as tiny, punctate, hyperechoic foci, either with or without acoustic shadowing and without comet tail artifacts) or macrocalcifications (larger than 1 mm).

Shape was categorized as taller than wide (antero-posterior dimension greater than transverse dimension) is round in shape or wider than tall (transverse dimension greater than antero-posterior dimension)- oval in shape.

USG findings were reviewed and the category of a particular lesion according to the TIRADS classification as suggested by Kwak et al. [10] was determined.

Data collection was done using a pretested semi structured questionnaire.

Data entry was done in Microsoft excel and was analysed using Software SPSS 20.0

Sensitivity, specificity, positive and negative predictive value, positive likelihood ratio and accuracy was determined for each category of TIRADS Univariate and multivariate analysis was done to quantify how strongly the presence or absence of a particular factor is associated with malignancy. This was done by measuring the odds ratio and p value using the chi square test. P value, and the odds ratio was calculated and used to evaluate the reliability of TIRADS in differentiating benign and malignant lesions. The odds ratio is determined to quantify how strongly the presence of a particular ultrasound feature is associated with malignancy in the study population.

The P values will be measured using chi square-test. In all analyses, $P < 0.01$ will be considered to indicate statistical significance. The number of benign cases determined by TIRADS that correlated correctly with the FNAC will be determined and subsequently, the reliability with which TIRADS could have avoided unnecessary FNACs will be calculated.

Ethical considerations

Prior approval was obtained from the ethics committee of our institute and a written informed consent was obtained from all patients. Participant information sheets are given to all the study subjects informing them about the procedure involved, also making them aware that they can withdraw from the study anytime they want and that this study would in no way influence their management in hospital.

IV. RESULTS

Out of the 155 patients 67(43.2%) were below the age of 40 years and 88 (56.8%) were 40 years and above; 125(80.6%) were females and 30 (19.4%) were males(Table 1). Among the nodules examined, 11% were cystic and 38.1% solid and 51% were of mixed in composition; 5(3.2%) were anechoic, 60(38.7%) hyperechoic, 37(23.9%) isoechoic, 28(18.1%) hypoechoic and 25(16.1%) markedly hypoechoic nodules(Table 2). 113(72.9%) nodules had well defined margins, 10(6.5%) had micro lobulated, 9 (5.8%) had ill-defined and 23(14.8%) had irregular margins. There were 40(25.8%) nodules with no calcification, 28(18.1%) with microcalcification, 55(35.5%) with macrocalcification and 32 (20.6%) had both types of calcifications. Among the nodules examined 61(39.4%) had a round shape and 94(60.6%) were oval in shape (Table 2).

Out of the 155 cases 24(15.5%) belonged to TIRADS 2, 54(34.8%) to TIRADS 3, 26(16.8%) to TIRADS 4A, 19(12.3%) to TIRADS 4B, 12(7.7%) to TIRADS 4C and 20 to TIRADS 5(Table 3).

The FNAC findings showed that there were 32(20.6%) papillary carcinoma, 5(3.2%) follicular carcinoma, 5(3.2%) medullary carcinoma, one (0.6%) anaplastic carcinoma and 4(2.6%) lymphomas. Majority of nodules 98(63.2%) were nodular colloid goiter, 8(5.2%) multinodular goiter and 2(1.3%) were multinodular goiter with hurthle cell change (Table 4). Out of the 155 nodules 108(69.7%) were benign and 47(30.3%) were malignant (Table 5).

In the 67 cases less than 40 years 49(73.1%) were benign and 18(26.9%) were malignant. Among 88 cases who were 40 or above, 59(67%) were benign and 29(33%) were malignant. When risk of malignancy with age was assessed for statistical significance with Chi-square test there was no significant association (p=0.414). Out of 30 males studied 18(40%) were malignant, while in the 125 females only 35(28%) were malignant. However when significance for occurrence of malignancy was assessed for statistical significance with chi-square test, there was no significant association (p=0.199) (Table 6).

14(82.4%) of the 17 cystic lesions and 65(82.3%) of 79 mixed lesions were found to be benign. Of the 59 solid lesion noted 30(50.8%) were malignant which was statistically significant with odds ratio of 4.83(1.26-18.57) and p value <0.01. All anechoic nodules and majority of nodules with hyperechogenicity(95%) and isoechogenicity(78.4%) found to be benign. Among the hypoechoic ones (57.1%) and markedly hypoechoic nodules 80% were found to be malignant. This was also statistically significant with p value<0.01. 84% of nodules with well-defined margin were benign while 66.7% of nodules with ill-defined and 78.3% of nodules with irregular margins were malignant. This was also statistically significant with chi square test with $\chi 2 = 46.56$, p value <0.01. While 90.9% of nodules with macrocalcification were found to be benign 82.1% with microcalcification were malignant. Hence the presence of microcalcification was highly predictive of malignancy and was statistically significant with $\chi 2 = 53.11$, p<0.01. 88.3% of nodules with oval shape were found to be benign while 59% of the round nodules were malignant. This was also statistically significant with chi square test $\chi 2 = 39.2$, p<0.01 (Table 7).

In the lower scores of TIRADS like 2, 3 and 4A, there were more benign nodules (91 %, 90 %, and 84 % respectively). Whereas in the higher scores, the percentage of malignant nodules are seen rising; 4B- 47 %, 4C-75 % and 5-90 % respectively (Table 8).

The predictive power of TIRADS scores are going high towards a malignant spectrum as the score goes high. The positive predictive value of a nodule to become malignant is 47.4 % in TIRADS 4B and 75 % and 90 % in TIRADS 4C and 5 respectively. As the nodules greater than a particular grade of TIRADS are grouped together and the results are compared, it is seen that if we take nodules greater than 4A as malignant, the sensitivity, specificity, PPV and accuracy are increased compared to the previous characterization (Table 9 vs Table 10).

V. DISCUSSION

Thyroid nodules, their characterisation and management is always a matter of debate among clinicians. Due to the increased prevalence of thyroid nodules, and their increased detection due to the widespread use of USG, how to proceed with the identified nodule is a matter of dilemma. In many studies, it is found that 19-35 % of thyroid nodules are incidentally detected using USG [11]. In the present scenario almost all thyroid cases are undergoing FNAC as a routine modality of investigation. But it is found that approximately 10-20 % of FNAC s are non-diagnostic in which the thyroid nodules show a high probability of malignancy and aspiration needs to be repeated [12]. Moreover approximately only 3–7% of thyroid FNACs have conclusive features of malignancy [7]. Because of all these reasons, there is always an imperative need to devise and follow a reliable protocol for the management of thyroid nodules, so that unnecessary biopsies can be avoided.

Several classification systems have been proposed to stratify the risk of malignancy in thyroid nodules. Most of them are complex using several ultrasound features and formulae which are not easy to use in daily practice, especially in a tertiary care teaching setup where examiners of varying [10] experience perform ultrasound scans. Of all the systems, the classification proposed by Kwak *et al*. [10] is simple and similar to the BIRADS system which has been in use for many years and is familiar to most radiologists. Therefore, we have aimed to assess the PPV of TIRADS as proposed by Kwak *et al*.[10].

Demographic data

In our study, the majority of the study population were females with a male to female ratio of 1:4.1. This was similar to other studies like Bhatnagar et al. [13] (1:5.1) and Dhanaram B et al. [14] (1:5.6) and Parthipan N et al. [15] (1:4). There was no statistically significant difference when age and gender were considered for appearance of a malignant nodule. (p value for age-0.414 and sex -0.199). This was similar to other studies like Chandramohan et al. [16], Sreenivas et al. [17], Bhatnagar et al. [13] and Kwak et al. [10].

Frequency of ultrasound features of thyroid nodules according to tirads descriptors.

Composition

In our study, 11 % were cystic nodules ,38.1 % solid and 51 % were mixed in composition. Studies done by Chandramohan et al.[16] had cystic 13.6 % , sold 69.4 % and mixed 17.1 %. Another study done by Bhatnagar et al.[13] showed 38.3 % solid, 41.7 % cystic and 20 % mixed nodules.

Echogenicity

There were 3.2 % anechoic , 38.7 % hyperechoic ,23.9 % isoechoic ,18.1 % hypoechoic ,16.1 % markedly hypoechoic nodules in our study. This was almost similar to other studies in literature .Studies by Chandramohan et al. [16] had 3.5 % anechoic, 16.2 % hyperechoic , 46.2 % isoechoic ,22.8 % hypoechoic and 11.3 % markedly hypoechoic, while Bhatnagar et al. [13] had 23.3 % hyperechoic, 30 % isoechoic ,10 % hypoechoic and 36.7 % markedly hypoechoic.

Margins

The present study had 72.9 % nodules with well defined margins, 6.5 % with microlobulated , 5.8 % ill defined, 14.8 % irregular. Chandramohan et al. [16] had 72.8 % well defined, 5.5 % microlobulated, 13.6 % ill defined and 8.1 % irregular margins.

Calcification

In our study, 25.8 % nodules had no calcification, 18.1 % showed microcalcification, 35.5 % showed macrocalcification and 20.6 % showed both. Bhatnagar et al. [13] had 33.3 % with no calcification, 33.3 % macrocalcification and 10 % microcalcification while Chandramohan et al. [16] had 67.1 % no calcification ,16.2 % microcalcification , 9.8 % macrocalcification and 6.9 % had both.

Shape

Present study had 39.4 % taller than wide nodules (round) and 60.6 % oval nodules. Chandramohan et al. [16] had 15 % round nodues and 85 % oval nodules.

Histopathology of the nodules

In our study on histopathological examination, 69.7 % nodules were found to be benign (63.2 % were nodular colloid goitre , 5.2 % MNG and 1.3 % nodular colloid goitre with hurthle cell change) and 30.3 % malignant.(20.6 % papillary carcinoma , 3.2 % follicular carcinoma, 3.2 % medullary carcinoma, 0.6 % anaplastic, 2.6 % lymphoma).

Histopathology of nodules in the study by Chandramohan et al. [16] were as follows, 33.3% were benign nodules , among which 28.6 % were adenomatous hyperplasia , 33.9 % nodular hyperplasia , 12.5 % hurthle cell adenoma, 10.7 % colloid cyst with haemorrhage, 8.9 % hashimoto's thyroiditis, and 5.4 % follicular adenoma and remaining 66.7 % malignant among which 51.8 % papillary carcinoma, 30.3 % follicular variant of papillary carcinoma, 2.7 % follicular carcinoma, 2.7 % medullary carcinoma, 1.8 % anaplastic carcinoma , 4.5 % poorly differentiated carcinoma and 1 % lymphoma.

In the study done by Kwak et al. [10] the histopathological findings were as follows, 80% were malignant nodules among which 95% was papillary carcinoma, 2% follicular variant of papillary carcinoma, 1.5% medullary carcinoma, 1% follicular carcinoma, 0.5% anaplastic carcinoma and 20% were benign among which 88% adenomatous hyperplasia, 6.7% follicular adenoma, 3.3% hurthle cell adenoma and 2% hyalinising trabecular tumour.

In both these studies the majority of the nodules were recorded histopathologically as malignant, unlike in our study which may be because the histopathological diagnosis was given only in those nodules which were treated with surgery.

Association between thyroid malignancy and various ultrasound features

In our study, univariate analysis revealed the below mentioned sonological features to have a significant association with malignant cytology.

- Solid composition
- Hypoechogenicity
- Marked hypoechogenicity
- Irregular margin
- Microcalcification
- Taller than wider shape (round).

Among these features in our study, marked hypoechogenicity was most sensitive for malignancy (odds 75.88), followed by microcalcification (odds 32.2), hypoechogenicity (odds 25.29) , irregular margins (odds 19), round shape (odds 10.87), solid composition (odds 4.83) in that order.

Kwak et al. [10] observed that irregular margin had highest odds (odds 113.8), followed by marked hypoechogenicity (odds 69.7), microcalcification (odds 25.8), taller than wide shape (odds 24.4) and solid composition (odds 9.15).

Srinivas et al. [17] had irregular margins (odds 1779.75) most sensitive for malignancy, followed by taller than wide shape (odds 367), microcalcification(odds 44.6), marked hypoechogenicity (odds 30.4) and solid composition (25.2).

Horvath et al. [18] found that hypoechogenicity, round shape ,irregular margins and microcalcifications were all features of malignancy .

Ultrasound features and their statistical parameters

Composition of nodule

In the present study, solid consistency as a predictor for malignancy had sensitivity of 63.83 % , specificity of 73.15 % , positive predictive value of 50.85 %, negative predictive value of 82.29 % and accuracy of 70.32%. Studies done by Koike et al. [3] had sensitivity of 83.4 and specificity of 81.8 %, Bhatnagar et al. [13] had sensitivity of 89 % , specificity of 70.5 %, positive predictive value of 34.7 %, negative predictive value of 97.3 %, Aggarwal et al. [20] had sensitivity of 54.5 % and specificity of 64.3 % for solid consistency. Sreenivas et al. [17] had a sensitivity of 52 %, specificity 95.8 %, positive predictive value 48.15 %, negative predictive value 96.45 %.

Echogenicity of the nodule

In our study, marked hypoechogenicity as a criterion for predicting malignancy had a sensitivity of 42.55%, specificity 95.37%, positive predictive value 80%, negative predictive value 79.2% and accuracy 79.35% . Srinivas et al got a sensitivity of 48%, specificity of 97.06%, positive predictive value of 54.55% , negative predictive value of 96.21% for marked hypoechogenicity as a predictor for malignancy. Koike et al.[3] got sensitivity of 95 % and specificity of 51.4 %, Papini et al. [2] had specificity of 48.6 % and sensitivity of 66.6 %, positive predictive value of 34 .4 % and negative predictive value 78.2 % , Bhatnagar et al. [13] got sensitivity of 78 % , specificity of 70.89 %, positive predictive value of 31.82%, NPV of 94.7 % for hypoechogenicity as a predictor of malignancy.

Margin of the nodule

Irregular margin as a predictor of malignancy had a sensitivity of 38.3 %, specificity of 95.37 %, positive predictive value of 78.26 % , negative predictive value of 78.03 % and accuracy of 78.06 % in our study. Bhatagar et al. [13] had sensitivity of 44.4 % , specificity of 94.12 % and positive predictive value of 57.14 %, Papini et al. [2] got sensitivity of 77.5 5 %, specificity of 85 %, and positive predictive value of 30 %. Srinivas et al. [17] had sensitivity of 84 %, specificity of 99.7 %, positive predictive value 95.45 %, NPV 98.83 %. Kim et al. [8] had sensitivity of 55.51 % , specificity of 83 %, positive predictive value of 60 % and negative predictive value of 80% when irregular margins were considered as a predictor of malignancy.

Calcification

Microcalcification as a predictor of malignancy had a sensitivity of 48.9 % , specificity 97.37 % , PPV 82.14 % , NPV 81.1 % and accuracy 81.29 % in our study. Srinivas et al. [17] had sensitivity of 40 % , specificity of 98.53 %, PPV 66.67 %, NPV 95.7 %.Bhatnagar et al. [13] had sensitivity of 33.3 % and specificity of 94.12 %, PPV 50 % and NPV 88.89 % for microcalcification as a predictor of malignancy.

Shape

In our study , taller than wide shape (round) in predicting malignancy had a sensitivity of 76.6 %, specificity 76.85 %, PPV 59 %, NPV 88.3 % and accuracy 76.7 %. Bhatnagar et al. [13] had sensitivity of 22.2 % , specificity of 100 %, PPV of 100 % ,NPV of 87.93 %. Srinivas et al. [17] had a sensitivity of 52 %, specificity of 99.7 % , PPV 92.86 % , NPV 96.5 % for taller than wide shape in predicting malignancy.

Risk stratification by TIRADS

In the present study out of 155 nodules,15.5 % belong to TIRADS 2 , 34.8 % TIRADS3 , 16.8 % TIRADS4A, 12.3 % TIRADS 4 B, 7.7 % TIRADS 4C, 12.9 % TIRADS 5.

Risk of malignancy in our study was 8.3 %, 9.3 %, 15.4 %, 47.4 %, 75 % and 90 % respectively for a TIRADS category 2, 3, 4A, 4B, 4C and 5 lesions. This showed an increasing risk and probability of malignancy as TIRADS category increases. This was in accordance to other studies in literature namely Kwak et al. [10] showing a risk of malignancy of 0%, 1.7%, 3.3%, 9.2%, 44.4-72.4%, 87.5% , Chandramohan et al. [16] shows a risk of 6.6 %, 32 %,36 % 64 % ,59 % and 91 %, Srinivas et al. [17] shows a risk of 0%, 0.64%, 4.76%, 66.67%, 83.33%, 100%, Fernandez Sanchez [20] shows 0 %, 0%,9.5 %,48 % ,85 % and 100 % in TIRADS 2,3,4A,4B,4C and 5 respectively. Similarly other studies also showed increasing risk of malignancy as TIRADS category increases with a 89.6 % , 100 % ,99.4% risk of malignancy in TIRADS 5 category by Horvath et al , Park et al and Kim et al respectively [8, 18, 21].

When TIRADS category more than 3 , (4A+4B+4C+5) was assigned to be malignant, the sensitivity was 85.1 %, specificity 65.7 %, PPV 51.9 % , NPV 91 % and accuracy was 71.6 %. There was an improvement in the specificity (65.7 % to 86.1 %), PPV (51.9 % to 70 .6 %) and accuracy (71.6 % to 83.2 %) when TIRADS category 4A nodules were reassigned to benign category.(4B+4C+5 malignant). Similar results were obtained in the study by Chandramohan et al. [16] where there was improvement in the PPV (from 64% to 75%) and specificity (from 69% to 85.5%) when TIRADS category 4a nodules were reassigned to category 3; however, sensitivity of TIRADS reduced (from 72% to 60%).

In the actual clinical setting, it may be practical to follow-up patients with just one suspicious feature and indeterminate cytology than subjecting them to surgery (Table 12)

VI. Conclusions

In this study, there was no statistical significance for the age or sex ratio in the study. There are a few sonological features which are highly predictive for malignancy in our study, they are solid composition, hypoechogenicity, marked hypoechogenicity, irregular margins, microcalcifications and taller than wider shape.

Among this marked hypoechogenicity was found to be having the highest sensitivity for malignancy followed by microcalcification, hypoechogenicity, irregular margins, round shape and solid composition.

We have also found that there is an increased risk and probability of malignancy as the TIRADS score goes high. Also there was a significant increase in the specificity, PPV and accuracy when TIRADS 4B+4C+5 were considered as malignant rather than considering nodules above TIRADS 3 as malignant.

VII. Limitations Of The Study

This study has several limitations. Being a tertiary care referral centre, the percentage (32%) of patients undergoing thyroid surgery after thyroid ultrasound was quite high and a large number of nodules included in the study were malignant. This would have caused a selection bias.

False-positive and false-negative cytology may have had an impact on the results obtained. Also ultrasound-guided FNAC was performed in only less than 20% of nodules which were either predominantly cystic, mixed,solid, and cystic nodules or were small and had suspicious features on ultrasound. Rest of the nodules underwent blind FNAC by surgeons of varying experience. This could have contributed to the high number of inadequate FNACs.

Finally, as also described by Kwak *et al*. [10] breast cancer and thyroid cancer are very different in terms of the prevalence, disease severity, clinical course, and temporal progression, hence we cannot be sure if we can apply similar systems for both these entities.

TABLES AND FIGURES

Table 1. Demographic profile of patients(n=155)

	Count	Percent
Age < 40years	67	43.2
>= 40years	88	56.8
Gender Male	30	19.4
Female	125	80.6

Table 2. Distribution of the sample features

Composition	**Count**	**Percent**
Cystic	17	11
Solid	59	38.1
Mixed	79	51
Echogenicity		
Anechoic	5	3.2

Hyperechoic	60	38.7
Isoechoic	37	23.9
Hypoechoic	28	18.1
Markedly Hypoechoic	25	16.1
Margin		
Well Defined	113	72.9
Microlobulated	10	6.5
Ill defined	9	5.8
Irregular	23	14.8
Calcification		
Nil	40	25.8
Microcalcification	28	18.1
Macrocalcification	55	35.5
Both	32	20.6
Shape		
Round	61	39.4
Oval	94	60.6

Table 3. Distribution of sample according to TIRADS

TIRADS	Count	Percent
2	24	15.5
3	54	34.8
4A	26	16.8
4B	19	12.3
4C	12	7.7
5	20	12.9

Table 4. Distribution of the sample according to histopathology

Histopathology	Count	Percent
Papillary CA	32	20.6
Follicular CA	5	3.2
Medullary CA	5	3.2
Anaplastic	1	0.6
Lymphoma	4	2.6
Nodular Colloid Goitre	98	63.2
Multinodular Goitre	8	5.2

Nodular Colloid Goitre with Hurthle cell change	2	1.3

Table 5. Distribution of sample according to natue

Nature	Count	Percent
Benign	108	69.7
Malignant	47	30.3

Table 6. Association of malignancy with demographics

Characteristic	Benign		Malignant		Odds (95% CI)
	Count	Percent	Count	Percent	
Age (p = 0.414)					
Age < 40(n=67)	49	73.1	18	26.9	1
Age >= 40(n=88)	59	67.0	29	33.0	1.34 (0.67 – 2.69)
Sex (p = 0.199)					
Male(n=30)	18	60.0	12	40.0	1.71 (0.75 – 3.92)
Female(n=125)	90	72.0	35	28.0	1

Table 7. Association of malignancy with selected variables

Characteristic	Benign		Malignant		Odds (95% CI)
	Count	Percent	Count	Percent	
Composition (p<0.01) Cystic(n=17)	14	82.4	3	17.6	1
Solid(n=59)	29	49.2	30	50.8	4.83 (1.26 – 18.57)
Mixed(n=79)	65	82.3	14	17.7	1.01 (0.25 – 3.97)
Echogenicity (p<0.01) Anechoic(n=5)	5	100.0	0	0.0	
Hyperechoic(n=60)	57	95.0	3	5.0	
Isoechoic(n=37)	29	78.4	8	21.6	
Hypoechoic(n=28)	12	42.9	16	57.1	
Markedly Hypoechoic(n=25)	5	20.0	20	80.0	
Margin (p<0.01) Well Defined(n=113)	95	84.1	18	15.9	1
Microlobulated(n=10)	5	50.0	5	50.0	5.28 (1.38 – 20.11)
Ill-defined(n=9)	3	33.3	6	66.7	10.55 (2.42 – 46.11)
Irregular(n=23)	5	21.7	18	78.3	19.00 (6.25 – 57.73)
Calcification (p<0.01) Nil (n=40)	25	62.5	15	37.5	4.2 (1.23 – 14.34)
Microcalcification(n=28)	5	17.9	23	82.1	32.20 (7.74 – 133.99)
Macrocalcification(n=55)	50	90.9	5	9.1	0.70 (0.17 – 2.82)
Both(n=32)	28	87.5	4	12.5	1
Shape (p<0.01) Round(n=61)	25	41.0	36	59.0	10.87 (4.83 – 24.42)
Oval(n=94)	83	88.3	11	11.7	1

Table 8. Distribution of malignancy at various TIRADS

TIRADS	Benign	Malignant	Total
2	22	2	24
3	49	5	54
4A	22	4	26
4B	10	9	19
4C	3	9	12
5	2	18	20
Total	108	47	155

Table 9. Predictive power of TIRADS in malignancy

	TIRADS					
	2	3	4A	4B	4C	5
Sensitivity	4.3	10.6	8.5	19.1	19.1	38.3
Specificity	79.6	54.6	79.6	90.7	97.2	98.1
Positive Predictive value	8.3	9.3	15.4	47.4	75.0	90.0
Positive Likelihood ratio	0.2	0.2	0.4	2.1	6.9	20.7
Accuracy	56.8	41.3	58.1	69.0	73.5	80.0

Table 10. Predictive power of TIRADS in malignancy

	TIRADS				
	>2	>3	>4A	>4B	>4C
Sensitivity	95.7	85.1	76.6	57.4	38.3
Specificity	20.4	65.7	86.1	95.4	98.1
Positive Predictive value	34.4	51.9	70.6	84.4	90.0
Positive Likelihood ratio	1.2	2.5	5.5	12.4	20.7
Accuracy	43.2	71.6	83.2	83.9	80.0

Table 11. Stasistical results of TIRADS –malignant features

TIRADS FEATURE	SENSITIVITY (%)	SPECIFICITY (%)	PPV (%)	NPV (%)	PLR	ACCURACY
Solid composition	63.83	73.15	50.85	82.29	2.38	70.32
Marked hypoechogenicity	42.55	95.37	80	79.2	9.19	79.35
Irregular margin	38.3	95.37	78.26	78.03	8.27	78.06
Microcalcification	48.94	95.37	82.14	81.1	10.57	81.29
Taller than wide shape	76.6	76.85	59	88.3	3.31	76.7

Table 12. Comparison of diagnostic performance of various studies to assess the thyroid nodules.

STUDY	TIRADS 2	TIRADS 3	TIRADS 4A	4B	4C	5
Present study	8.3 %	9.3	15.4	47.4	75	90
Kwak et al [10]	0	1.7	3.3	9.2	44.4-72.4	87.5
Chandramohan et al [16]	6.6	32	36	64	59	91
Horvath et al [19]	0	14.1	45			89.6
Srinivas et al [17]	0	0.64	4.76	66.67	83.33	100

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