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RESEARCH ARTICLE

CORRELATION OF TIRADS [THYROID IMAGING REPORTING AND DATA SYSTEM] AND HISTOPATHOLOGICAL FINDINGS IN EVALUATION OF THYROID NODULES.

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Key words:-
Echogenicity, TIRADS, Microcalcification, Irregular contours.

Abstract

Purpose: Ultrasound [US] is an excellent noninvasive modality to evaluate thyroid nodules.Aim of our study was to characterize the thyroid nodules according to grey scale sonographic features into high suspicious ,probably benign, benign aspects and normal thyroid using TIRADS scoring system and to characterize the thyroid nodule according to the sonographic features into a specific TIRADS stage and correlate the results with the histopathological examination findings wherever possible.

Material And Methods: The prospective study was carried out on 60 patients referred to Department of Radiodiagnosis, Rajindra Hospital,Patiala. All the patients were subjected to detailed history taking,clinical examination and routine laboratory investigations.All thyroid nodules were characterized according to the internal component[solid, mixed or cystic], the margins, echogenicity [hyperechoic, Isoechoic,hypoechoic, marked hypoehoic], evidence of calcification [microcalcification if less than 3mm and macrocalcification if more than 3mm with acoustic shadowing]and the shape[taller than wide if greater in anteroposterior dimension than in its transverse dimension and wider than tall]. Using the Modified Russ Classification, each nodule was classified into TIRADS categories [1,2,3,4A,4B and 5] based on ultrasound features.The patients were referred to Department of Pathology, Government Medical College Patiala and FNAC was done. The US findings were correlated with FNAC and data was analyzed statistically.

Results: Based on various ultrasound characteristics of thyroid nodules,TIRADS score was given to each thyroid nodule and then FNAC was done.The results of histopathology were correlated with ultrasound features and statistical analysis was done calculating sensitivity, specificity,positive predictive value and negative predictive value for each feature.The sensitivity and specificity for Irregular contours were 44.4% and 94.12%,for taller than wide were 22.22% and 100%,for microcalcification were33.3.3% and 94.12%,for marked hypoechogenicity was 78 and 70.89% and for solid consistency were89 and 70.5%.The risk of malignancy was found to increase from TIRADS3 to TIRADS5 in this study. All the cases [100%] of TIRADS 5 turned out to be malignant on histopathology.

Conclusion: Radiologists should be aware of usefulness of specific ultrasound features of thyroid nodules like Irregular contours, taller

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than wide configuration, microcalcification, marked hypoechogenicity and solid consistency collectively taken as TIRADS for better differentiation of benign from malignant or potentially malignant lesions that warrant further diagnostic evaluation. The risk of malignancy was found to increase from TIRADS 3 to TIRADS 5 when different TIRADS categories were confronted with results of pathology and risk of malignancy was calculated.

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Introduction:-

Thyroid nodules are a commonly encountered clinical problem in daily practice.With the increased use of high resolution ultrasound during last two decades,the detection rate has gone up[1].This is in parallel to increased incidence of thyroid cancer worldwide since malignancy comprises approximately 5% of all Thyroid nodules irrespective of size[2]. The initial evaluation of thyroid nodules should always focus on exclusion of malignancy[4].The prevalence of non-palpable nodules has increased recently as a consequence of the increasing application of ultrasound[5].Nowadays, the use of high technology US equipment may detect nodules as small as 2 to3 mm, which raises the question of which thyroid nodules are clinically relevant for further evaluation[3].Various ultrasound characteristics of thyroid nodules have proven to have predictive diagnostic value in suspicion of malignancy,with particular focus on which nodules should be subjected to US guided fine needle aspiration [FNA].Thyroid US should always include evaluation of neck for abnormal lymph nodes. When abnormal lymph nodes are present, biopsy for cytology and thyroglobulin washout should be performed at the same time as the nodule biopsy [6].Fine Needle Aspiration Cytology [FNAC] is considered the most reliable test for diagnosis of thyroid nodules. FNAC is recommended for palpable nodules, but the indication for this procedure in non-palpable nodules is a matter of controversy.Some clinicians recommend ultrasound guided FNAC while others consider that a clinical follow up [neck palpation] is sufficient in absence of history of familial thyroid cancer or head/neck irradiation[5].Neck US has long been used to evaluate the size,character and location of thyroid nodules, monitor nodule growth and identify loco-regional lymphadenopathy. Many studies have classified specific US characteristics predictive of malignant nodules.For instance, current US characteristics that are strongly correlated with malignancy include intranodular vascularity,the presence of microcalcifications, a taller than wider pattern, hypoechogenicity and spiculated margins[7]. Although controversial, the current guidelines state that if any one of the above findings is observed,with the exception of increased intranodular vascularity, the nodule should be defined as suspicious for malignancy.

Materials And Methods:-

In this prospective study, we considered 60patients referred to Department of Radiodiagnosis, Rajindra Hospital Patiala. Prior permission regarding this study was taken from hospital authorities.The Thyroid was imaged with high frequency linear array transducer with the patient in supine position with neck extended by placement of a pillow beneath the shoulders.The number, location, size in three dimensions and characteristics of nodules were documented along with examination of neck adenopathy. Ultrasound was performed with Philips Envisor with a 5.5MHz probe. All the patients were subjected to detailed history taking, clinical examination, routine laboratory investigations and high resolution ultrasonography. All Thyroid nodules were characterized according to the internal components [solid, cystic, mixed], the margins, echogenicity, type of calcification if present [micro less than3mm and macro if more than3mm], the shape of the nodule [characterised as “taller than wider”[greater in anteroposterior dimension than in its transverse diameter and “wider than taller”]. Using the Modified Russ classification,each nodule was classified into TIRADS category [1,2,3,4A,4B,5] based on ultrasound features.The findings were correlated with FNAC.Then data was analyzed statistically.

Tirads Classification Alogrithm:-

The terminology of TIRADS was first used by Hogarth et al.They described 10 ultrasound patterns of thyroid nodules and related the rate of malignancy according to the pattern.The followingcategories were established:

TIRADS 1:Normal Thyroid gland

TIRADS 2:Benign conditions [0%malignancy]

TIRADS 3:Probably benign nodules [5%malignancy]

TIRADS 4:Suspicious nodules [5-80%malignancy].A subdivision into 4a[malignancy between 5and10%] and 4b[malignancy between 10 and 80%] was optional.
TIRADS 5:Probably malignant nodules[malignancy 80%]
TIRADS 6:Category included biopsy proven malignant nodules.

Tirads Classification Alogrithm

HIGH SUSPICIOUS ASPECTS • Taller than wide shape • Irregular or microlobulated margins • Microcacifications • Marked hypoechogenicity	≥3 signs and /or adenopathy TIRADS 5 1 or 2 signs and no adenopathy TIRADS 4B
LOW SUSPICIOUS ASPECTS • None of the high suspiciousaspects • Moderately hypoechogenic	TIRADS 4A
PROBABLY BENIGN ASPECTS • None of the high suspicious aspects • Isoechogenicity • Hyperechogenic	TIRADS 3
BENIGN ASPECTS • Simple cyst • Spongiform nodule • "White knight'' aspect • Isolated microcalcification • Typical subacute thyroiditis	TIRADS 2
Normal Thyroid USG	TIRADS 1

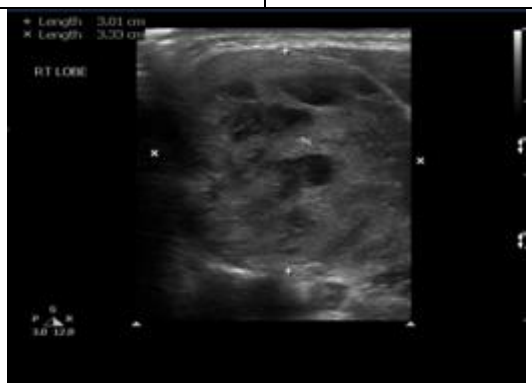


Figure 1:- A well defined wider than tall hyperechoiec nodule seen in the right lobe of thyroid with few cystic areas with no calcification. (TIRADS CATEGORY III)

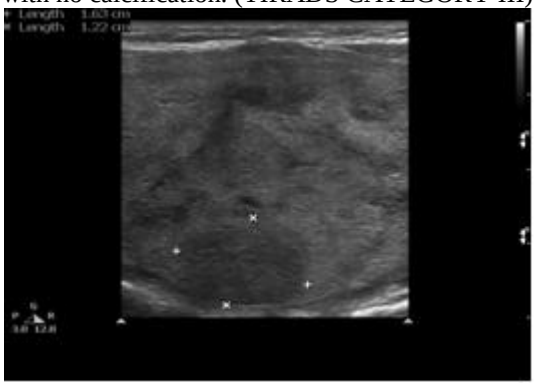


Figure 2:- A well defined moderately hypoechoiec area is seen in the thyroid with no calcification.(TIRADS CATEGORY IV A)

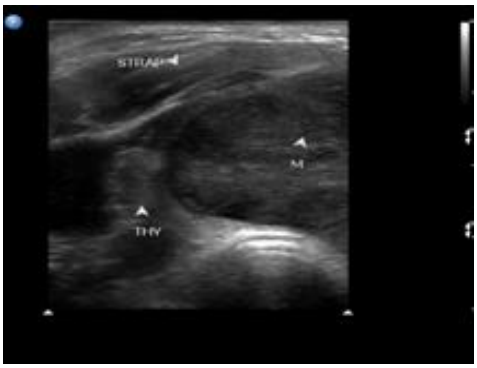


Figure 3:- An ill defined markedly hypoechoiec nodule as compared to strap muscles

Figure 4:- An ill defined taller than wide markedly hypoechoiec nodule with micro calcifications.(TIRADS CATEGORY V)

Results:-

Our study consisted of 60 patients with male to female ratio of 1:5.1. 16.67%were males and 83.33% were females.Purely solid nodules were seen in 23 [38.3%] cases. Solid nodules with cystic components were seen in12 [20%] cases. Purely cystic nodules were seen in 25 [41.7%] cases out of 60.Hyperechoic nodules were seen in 14 [23.33%]cases whereas Isoechoic nodules were seen in 18[30%] cases.Hypoechoic nodules were seen in 06[10%] cases and marked hypoechoicnodules were seen in 22 [36.7%] cases. Sharp well defined margins were seen in53[88.3%] of cases. Poorly defined margins were seen in 07[11.7%] of cases.Microcalcification was seen in 06[10%] cases and macrocalcification was seen in 20[33.3%] cases.No calcification was seen in 34 [33.3%]cases.Taller than wide shape of the nodules was seen in 02 [3.33%] of cases and wider than tall shape was seen in 58[96.7%]cases.In our study on US, we diagnosed 52 nodulesas benign and 8 nodules as malignant nodules.15 [28.84%] of the benign nodules were solid and 08[100%] of the malignant nodules were solid.12 [23.07%] of the benign nodules were mixed while none of the malignant nodules was mixed. 25 [48%] of the benign nodules were cystic and none of the malignant nodules was cystic. On correlation of echogenicity of nodules on ultrasound with histopathological findings,15[28.3%] nodules were markedly hypoechoic and 07 of them turned out to be malignant while 14 [26.4%]were hyperechoic and none of them turned out to be malignant. On correlation of margins of nodules with histopathological findings 53[94.64%]cases with well defined margins turned out benign on histopathology and04[100%] of cases having ill defined margins were found to be malignant. None of the malignant nodules showed well defined margins.On correlation of pattern of calcification and histopathology,microcalcification was seen in 03[13%]of the benign nodules and 03[100%] of malignant nodules.Macrocalcification was seen in 20[87%]of benign nodules. None of the malignant nodules showed macrocalcification.Taller than wide configuration was seen in 02[100%] of the malignant nodules and wider than taller configuration was seen in 58[100%] of the benign nodules. Major ultrasound featuressuggestive of malignancy were analyzed with respect to TIRADS category.Sensitivity, specificity, positive predictive value and negative predictive value were calculated for each feature (Table1). Diagnostic index of individual grey scale sonographic criteria for predicting malignancy in Thyroid nodules was calculated.

Table 1:- Ultrasound features and their statistical parameters

Ultrasound feature	True positive	False positive	True negative	False negative
IRREGULAR CONTOURS	O4	03	48	O5
TALLER THAN WIDE	02	00	51	07
MICROCALCIFICATION	03	03	48	06
MARKED HYPOECHOGENICITY	07	15	36	02
SOLID CONSISTENCY	08	15	36	01

The sensitivity and specificity for Irregular contours were 44.4% and 94.12%,for taller than wide was 22.22% and 100%,for microcalcification were33.3% and94.12%, for marked hypoechogenicity were 78 and 70.89% and for solid consistency were 89and70.5%.

Table 2:- Tirads Categories Of Various Nodules

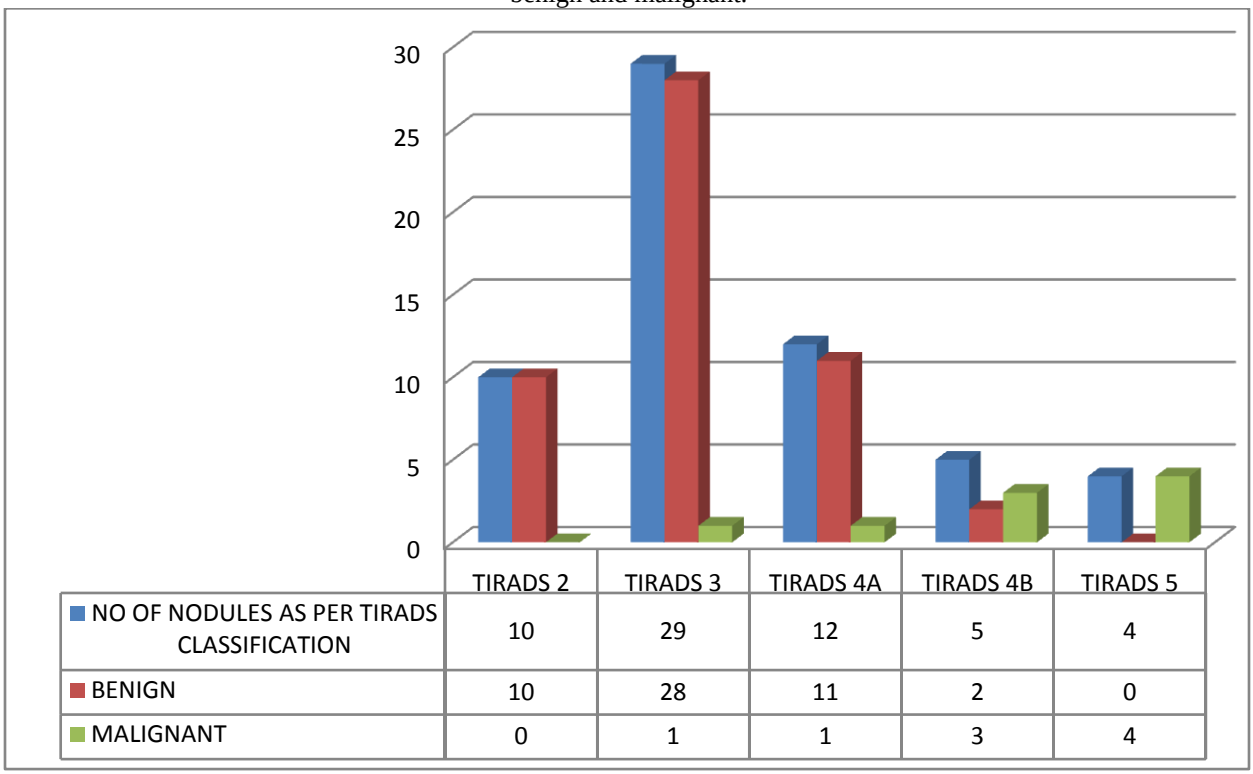
TIRADS CATEGORY	NO OF NODULES AS PER TIRADS CLASSIFICATION
TIRADS 2	10
TIRADS 3	29
TIRADS 4A	12
TIRADS 4B	05
TIRADS 5	04

The different TIRADS categories were compared with the results of pathology and risk of malignancy was calculated.The risk of malignancy was found to increase from TIRADS3 to TIRADS 5 (Table 3).

Table3:- Tirads Categories And Risk Of Malignancy

TIRADS CATEGORY	PATHOLOGY		TOTAL	RISK OF MALIGNANCY[%]
	BENIGN	MALIGNANT		
TIRADS2	10	00	10	00
TIRADS 3	28	01	29	3.4
TIRADS 4A	11	01	12	8.3
TIRADS 4B	02	03	05	60
TIRADS 5	00	04	04	100

Table 4:- Bar diagram shows number of nodules according to TIRADS categories and their charaterization into benign and malignant.



	TIRADS 2	TIRADS 3	TIRADS 4A	TIRADS 4B	TIRADS 5
NO OF NODULES AS PER TIRADS CLASSIFICATION	10	29	12	5	4
BENIGN	10	28	11	2	0
MALIGNANT	0	1	1	3	4

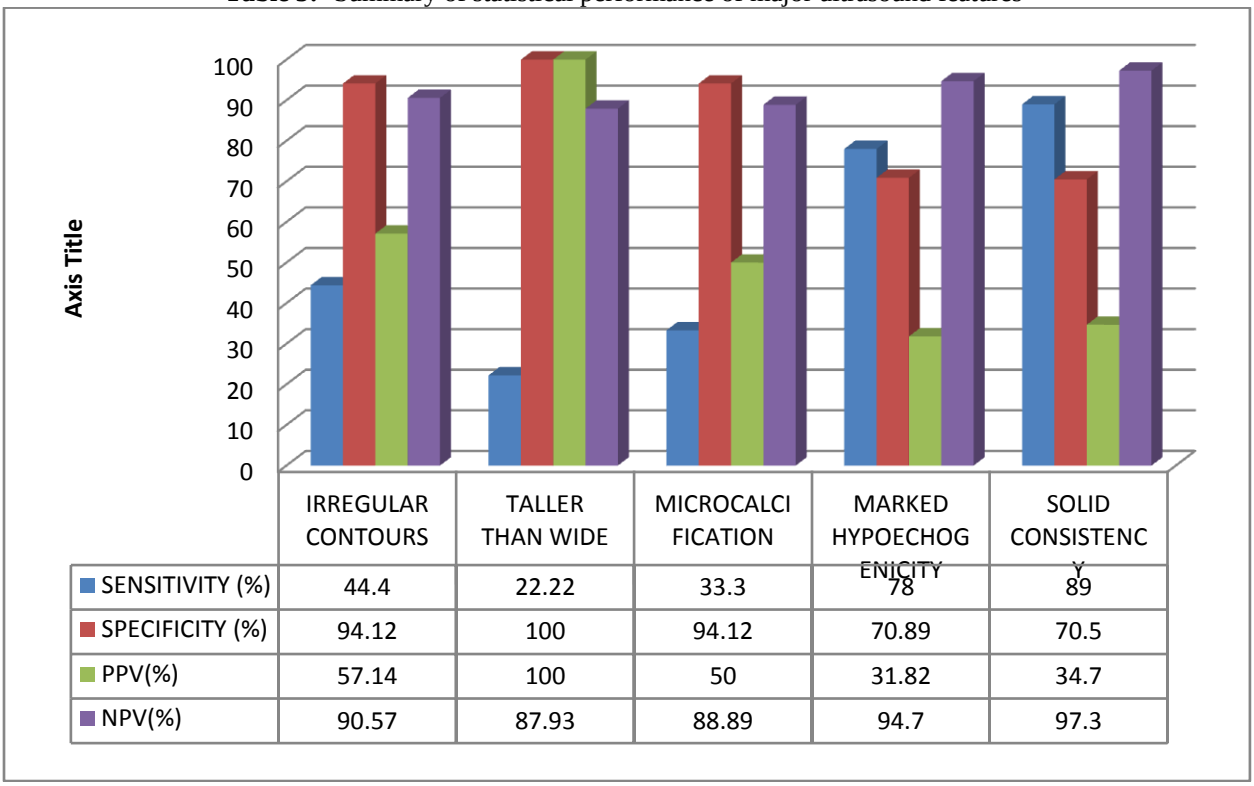
TIRADS categories and diagnostic performance of ultrasound was analysed.Total cases of TIRADS 2,3,4A were 51 out of which 49 were benign and 2 were malignant.Total cases of TIRADS 4B and 5 were 9 out of which 7 were malignant.Out of 51cases, 9 cases were malignant.

Discussion:-

In present study, 60 cases of nodular thyroid disease were studied by grey scale ultrasonography.We differentiated Thyroid nodules into highly suspicious, low suspicious, probably benign, benign nodules and normal thyroid as per TIRADS scoring system using grey scale scoring sonographic features viz internal components [solid, mixed or cystic], the margins,echogenicity,evidence of calcification and shape. Grey scale ultrasonography was the first investigation to be requested in all cases of thyroid swelling in our study because of it being noninvasive,simple and without radiation exposure.In our study, solid consistency as a predictor for malignancy had sensitivity of 70.5%, positive predictive value of 34.7% and negative predictive value of 97.3%. Study conducted by Aggarwal et al[11] showed that solid echotexture had sensitivity of 54.5% and specificity of 64.3%. koike et al [12] got sensitivity of 83.4% and specificity of 81.8% of solid echotexture of malignant nodules.In our study hypoechogenicity as criteria for predicting malignancy had sensitivity of 78%,specificity of 70.89%,positive predictive value of 31.82% and negative predictive value of 94.7%.Koike et al[12] got sensitivity of 95% and specificity of 51.4%. Raho et al[10] reported that hypoechogenicity had specificity of 48.6% and sensitivity of 66.6%, positive predictive value of 34.4% and negative predictive value of 78.2%.Papini et al[10] could predict malignancy in thyroid nodules using hypoechogenicity as criteria with sensitivity of 87.1%, specificity of 43.4% and positive predictive value of 11.4%. In our study, poorly defined Irregular margins had sensitivity of 44.4%, specificity of 94.12% and positive predictive value of 57.14%.Papini et al[10] reported Irregular margins as independent risk factor of malignancy with sensitivity ofn77.5%,specificity of 85% and positive predictive value of 30%. Kim et al[9] had sensitivity of 55.51%,specificity of 83%, positive predictive value of 60% and negative predictive value of 80%. Sajjadieh et al[15] had sensitivity of 42%,specificity of 71%,positive predictive value of 20%,negative predictive value of 87%, when irregular margins were considered. Moifo et al[16] showed sensitivity of 34.78% and specificity of 99.51%.In present study, microcalcification for predicting malignancy had sensitivity of 33.3%,specificity of 94.12%, positive predictive value of 50% and negative predictive value of 88.89%.In study conducted by Papini et al[10], sensitivity of microcalcification as a predictor of malignancy was 29% and Jason et al[13] showed specificity of 94.45%.Moifo et al[16] showed sensitivity of 30.4% and specificity of 98.8%.In present study, taller than wide for predicting

malignancy had sensitivity of 22.2%,specificity of 100%,positive predictive value of 100% and negative predictive value of 87.93%. In study conducted by Moifo et al[16] taller than wide for predicting malignancy had sensitivity of 4.35%,specificity of 100%, positive predictive value of 100% and negative predictive value of 94.87%.In our study probably benign US findings were seen in 51 patients and probably malignant US findings in 9 patients. Howarth suggested a malignant risk of less than 5% for TIRADS 3,5%to10% for TIRADS4b and greater than 80% for TIRADS5.Our findings were within this range suggested by Hogarth[8], Russ et al[17] and Moifo et al[16]. Another study conducted by Hong et al[18] concluded that the three sonographic features that are meaningful findings in the diagnosis of thyroid malignancy were the presence of microcacifications,marked hypogenecity and a taller than wide shape. In a multimeter Korean retrospective study, the ultrasound features that were statistically significant for malignancy were hypoechogenicity, marked hypoechogenicity,nonparametric orientation, microlobulated or spiculated margin, an ill defined margins and the presence of microcalcifications.

Table 5:- Summary of statistical performance of major ultrasound features



	IRREGULAR CONTOURS	TALLER THAN WIDE	MICROCALCIFICATION	MARKED HYPOECHOGENICITY	SOLID CONSISTENCY
SENSITIVITY (%)	44.4	22.22	33.3	78	89
SPECIFICITY (%)	94.12	100	94.12	70.89	70.5
PPV(%)	57.14	100	50	31.82	34.7
NPV(%)	90.57	87.93	88.89	94.7	97.3

Table 6:- Comparison of risk of malignancy in different TIRADS categories in present study with that of previous published studies

TIRADS CATEGORY	Risk Of Malignancy (%) Moifo et al (43)	Risk Of Malignancy (%) Horvath et al (8)	Risk Of Malignancy (%) Present study
TIRADS 2	0	0	00
TIRADS 3	2.2	<5	3.4
TIRADS 4A	5.9	5-10	8.3
TIRADS 4B	57.9	10-80	60
TIRADS 5	100	>80	100

Conclusion:-

Radiologists should be aware of usefulness of specific ultrasound features of thyroid nodules like Irregular contours, taller than wide configuration, microcalcifications, marked hyoechogenicity and solid consistency collectively taken as TIRADS for better differentiation of benign lesions from malignantor potentially malignant lesions that warrant further diagnostic evaluation. The sensitivity and specificity for Irregular contours were 44.4% and 94.12%, for taller than wide were 22.22% and 100%, for microcalcification were 33.3% and 94.12%, for marked

hypoechogenicity were 78% and 70.89% and for solid consistency were 89 and70.5%.The risk of malignancy was found to increase from TIRADS 3 to TIRADS5 when the different TIRADS categories were confronted with the results of pathology and risk of malignancy was calculated.

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