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Original article:

Assessment of malignant risk potential of thyroid nodules using ultrasound thyroid imaging reporting and data system (TIRADS) criteria

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Abstract:

Objective: The objective of this study was to determine the ultrasonographic features of thyroid nodules that could distinguish between benign and malignant tumors.

Methods: A retrospective study was conducted on 100 patients who underwent thyroid ultrasonography and biopsy. The study group consisted of 90 patients with benign thyroid nodules and 10 patients with malignant thyroid nodules. The ultrasound characteristics analyzed included age, gender, number of nodules, shape, echogenicity, content, calcification, margin, and TIRADS category.

Results: The study found that the majority of patients with both benign and malignant thyroid nodules were female. The age distribution differed between benign and malignant tumors, with a higher percentage of malignant tumors found in patients aged 51-60 years. Regarding nodule characteristics, benign and malignant nodules were similar in terms of the presence of multiple nodules. However, the shape, echogenicity, content, calcification, margin, and TIRADS category were found to be significant differentiators between the two types of nodules.

Conclusion: The findings of this study suggest that ultrasound characteristics such as shape, echogenicity, content, calcification, margin, and TIRADS category can be useful in distinguishing between benign and malignant thyroid nodules.

Keywords: thyroid, nodules, ultrasonography, biopsy, benign, malignant, shape, echogenicity, content, calcification, margin, TIRADS category.

Introduction:

Thyroid nodules are a common finding in clinical practice, with prevalence rates of up to 68% in certain populations. [1]Although the majority of thyroid nodules are benign, the possibility of malignancy cannot be ruled out, and accurate assessment of malignant risk potential is crucial for appropriate management. Ultrasound is the primary imaging modality for evaluating thyroid nodules, and various scoring systems have been developed to

standardize reporting and aid in risk stratification.[2,3]

One such scoring system is the Thyroid Imaging Reporting and Data System (TIRADS), which was developed by the American College of Radiology in 2017. TIRADS is a standardized method for characterizing thyroid nodules based on ultrasound features such as size, composition, echogenicity, margins, and the presence of calcifications or other suspicious features. The TIRADS system assigns each nodule a score from 1 to 5, with higher scores indicating a higher likelihood of malignancy.[4,5,6]

The use of TIRADS has been shown to improve the accuracy of ultrasound-based risk stratification for thyroid nodules, with studies demonstrating a sensitivity of up to 95% and a specificity of up to 77% for predicting malignancy. The TIRADS scoring system has also been shown to be useful in guiding decision-making regarding biopsy and surgical management of thyroid nodules, as higher TIRADS scores are associated with a higher risk of malignancy and a greater likelihood of requiring intervention.[7]

Overall, the TIRADS system provides a valuable tool for assessing the malignant risk potential of thyroid nodules, and has the potential to improve patient outcomes through more accurate risk stratification and appropriate management.

Material and methods:

The present study was a cross-sectional study conducted at the Department of Radiology of teaching hospitals attached to Bapuji Education Association, JJM Medical College, Davanagere, India, for a period of 18 months, from March 2021 to September 2022. Ethical clearance for the study was obtained from the institutional ethics committee prior to the commencement of the study.

The study included a total of 100 cases who met the inclusion criteria. The inclusion criteria consisted of patients of any age group and both sexes, who presented to the hospital with primary thyroid-related complaints and were referred to the radiology department for ultrasonography of the thyroid gland for the evaluation of thyroid nodules. Patients with secondary thyroid-related disorders such as drug/radiation-induced hypo/hyperthyroidism, systemic or central nervous system-related secondary thyroid involvement, and pregnant women were excluded from the study. Patients who were not capable of giving consent (psychiatric patients), patients who were willing to undergo ultrasonography of the thyroid gland but not willing to undergo ultrasound-guided fine-needle aspiration cytology, and patients who refused to give consent were also excluded from the study.

Before including the study subjects, an informed, bilingual, and written consent was obtained from each participant. Ultrasonography of the thyroid gland was performed by a trained radiologist using a high-resolution ultrasound machine. The thyroid nodules were evaluated according to the Thyroid Imaging Reporting and Data System (TIRADS) criteria. The TIRADS score was determined based on the size, composition, echogenicity, margins, and the presence of calcifications or other suspicious features of the nodules.

The patients underwent high resolution real time ultrasonography (gray scale and color doppler) of thyroid gland for the presence of thyroid nodules and also various other sonographic findings of the thyroid nodules were analysed. The key ultrasound features that were analysed include the shape of the nodules (wider-than-taller /taller-than-wider), echogenicity (iso/hyper-echogenicity, hypo-echogenicity, marked hypo-echogenicity), margins (smooth, irregular, micro-lobulated), content (solid, cystic or mixed) and calcification

(no calcification, micro-calcification, macro-calcification). Based on the ultrasound features the thyroid nodules are categorized into appropriate Thyroid Imaging Reporting And Data System category.

Results:

About 34.4% of the cases with benign tumors were aged between 41 – 50 years and 40.0% of the malignant cases were aged between 51 – 60 years. This difference was not statistically significant.

This study had shown that, about 81.0% of the cases with benign tumors and 70.0% of the cases with malignant tumor were females. This difference was not statistically significant.

Multiple nodules were present in 6.7% of the benign cases and 10.0% of the malignant disease cases in this study. This difference was not statistically significant between the benign and malignant cases.

Table 1. Distribution of the study group according to shape

Shape	Benign n (%)	Malignant n (%)
Taller than wider	0	4 (40.0)
Wider than taller	90 (100.0)	6 (60.0)
Total	90 (100)	10 (100)

χ^2 value= 37.5 df=1 p value, Sig=0.000, Sig

The tumors of all the benign cases 60.0% of the malignant cases were taller than wider. This difference in shape was statistically significant between the benign and malignant cases.

Table 2. Distribution of the study group according to echogenicity

Echogenicity	Benign n (%)	Malignant n (%)
Hypoechogenicity	12 (13.3)	3 (30.0)
Hyperechogenicity	69 (76.7)	0
Isoechogenicity	9 (10.0)	0
Marked Hypoechogenicity	0	7 (70.0)
Total	90 (100)	10 (100)

χ^2 value= 73.333 df=3 p value, Sig=0.000, Sig

About 76.7% of the cases with benign tumors had hyper echogenicity and 70.0% of the cases had hypoechogenecity which was statistically significant.

Table 3. Distribution of the study group according to content

Content	Benign n (%)	Malignant n (%)
Mixed	48 (53.3)	0
Solid	42 (46.7)	10 (100.0)
Total	90 (100)	10 (100)

χ^2 value= 10.256 df=1 p value, Sig=0.001, Sig

The content of the benign tumors was mixed in 53.3% of the cases and solid in all the malignant disease cases which was statistically significant.

Table 4. Distribution of the study group according to calcification

Calcification	Benign n (%)	Malignant n (%)
Absent	84 (93.3)	3 (30.0)
Macrocalcification	5 (5.6)	0
Microcalcification	1 (1.1)	7 (70.0)
Total	90 (100)	10 (100)

χ^2 value= 58.094 df=2 p value, Sig=0.000, Sig

Calcification was absent in 93.3% of the cases with benign tumors and 70.0% of the cases with malignant disease had microcalcification which was statistically significant.

Table 5. Distribution of the study group according to margin

Margin	Benign n (%)	Malignant n (%)
Irregular	23 (25.6)	4 (40.0)
Microlobulated	0	5 (50.0)
Smooth	67 (74.4)	1 (10.0)
Total	90 (100)	10 (100)

χ^2 value= 51.192 df=2 p value, Sig=0.000, Sig

The margin of the tumor was smooth in 74.4% of the benign cases and microlobulated in 50.0% of the malignant cases which was statistically significant between the benign and malignant tumors.

Table 6. Distribution of the study group according to TIRADS category

TIRADS category	Benign n (%)	Malignant n (%)
3	62 (68.9)	0
4A	12 (13.3)	1 (10.0)
4B	16 (17.8)	4 (40.0)
5	0	5 (50.0)
Total	90 (100)	10 (100)

χ^2 value= 54.189 df=3 p value, Sig=0.000, Sig

About 68.9% of the cases with benign tumors had TIRADS category 3 and 50.0% of the malignant cases had TIRADS category 5. This difference was statistically significant between the benign and malignant cases.

Discussion:

Thyroid nodules are very prevalent – they are found in approximately 8% of adults by palpation, 41% by means of ultrasound and in 50% in autopsy pathological examination.[1] By just palpation, the prevalence rate ranges from 4 to 7%.[2] In order to avoid misinterpretation, the thyroid nodules were classified into TIRADS (Thyroid Imaging Reporting And Data System) category based on suspicious ultrasound features. This enables objectivity of reporting, risk stratification and guidance for the clinician towards the next step.[8,9]

A cross sectional study was undertaken 100 cases of thyroid nodules in a tertiary care center of central Karnataka. Single nodule was present in 93.3% of the benign cases and 90.0% of the malignant cases in this

study which was not statistically significant. Multiple nodules were present in 6.7% of the benign cases and 10.0% of the malignant disease cases in this study. This difference was not statistically significant between the benign and malignant cases.

The tumors of all the benign cases 60.0% of the malignant cases were taller than wider. This difference in shape was statistically significant between the benign and malignant cases. A study by Srinivas et al had noted that 1 benign tumor and 13 malignant cases had taller than wider shape of lesions.[41] A study by Moifo et al reported a sensitivity of 4.35%, specificity of 100%, PPV of 100% and NPV of 94.87%.[40]

About 76.7% of the cases with benign tumors had hyper echogenicity and 70.0% of the cases had hypo echogenicity which was statistically significant. A study by Srinivas et al noted marked hypo echogenicity in 10 benign cases and 12 malignant cases.[41] A study by Mofio et al had shown a sensitivity of 13.04%, specificity of 99.51%, PPV of 60.0% and NPV of 95.29% with an odds ratio of 12.75.[40] A study by Kwak et al, reports the odds ratio for marked hypoechogenicity, irregular margins, microlobulated margins and microcalcification.[4]

The content of the benign tumors was mixed in 53.3% of the cases and solid in all the malignant disease cases which was statistically significant. A study by Srinivas et al noted that, the solid composition was present in 14 benign cases and 13 malignant cases.[41]

Calcification was absent in 93.3% of the cases with benign tumors and 70.0% of the cases with malignant disease had microcalcification which was statistically significant. A study by Srinivas et al had noted microcalcification in 5 benign cases and 10 malignant cases.[41] A study by Moifo et al reported a sensitivity of 30.4%, specificity of 98.8%, PPV of 58.3% and NPV of 96.2% with an odds ratio of 15.24 for the microcalcification.[40]

The margin of the tumor was smooth in 74.4% of the benign cases and microlobulated in 50.0% of the malignant cases which was statistically significant between the benign and malignant tumors. A study by Srinivas et al had noted that, the irregular margins were present in 1 benign case and 21 malignant cases.[41] Moifo et al reported that the presence of irregular contour of the thyroid nodules had the sensitivity, specificity of 34.78%, 99.51% respectively.[40]

About 68.9% of the cases with benign tumors had TIRADS category 3 and 50.0% of the malignant cases had TIRADS category 5. This difference was statistically significant between the benign and malignant cases. A study by Srinivas et al had noted that, the risk of malignancy in TIRADS categories was 0% in category 1, 0 in category 2, 0.64% in category 3, 4.76% in category 4A, 66.67% in category 4B and 83.33% in category 4C and 100% in category 5.[41] A study by Junior et al reported that, 0.8% of category 2, 1.7% of category 3, 16.0% of category 4A, 43.2% of category 4B, 72.7% of category 4C and 91.3% of category 5 cases were malignant tumours.[12]

The content of the nodules also showed a significant difference between the benign and malignant cases. The majority (53.3%) of benign nodules had mixed content, whereas all malignant nodules were solid. This finding suggests that the presence of solid content may indicate a higher likelihood of malignancy. Calcification was another factor that showed a significant difference between benign and malignant cases. Absent calcification was observed in the majority (93.3%) of benign nodules, whereas 70.0% of malignant nodules had microcalcification. This finding suggests that the presence of microcalcification may be an important predictor of malignancy.

Finally, the margin of the nodules showed a significant difference between benign and malignant cases. The majority (74.4%) of benign nodules had a smooth margin, whereas 50.0% of malignant nodules had a microlobulated margin. This finding suggests that the presence of a microlobulated margin may indicate a higher likelihood of malignancy.

Conclusion:

In conclusion, this study highlights the importance of considering multiple factors when diagnosing thyroid nodules. Shape, echogenicity, content, calcification, and margin all showed significant differences between benign and malignant nodules, suggesting that these factors may be important predictors of malignancy. Incorporating these factors into diagnostic algorithms may improve the accuracy of thyroid nodule diagnosis and ultimately lead to better patient outcomes.

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