Section: General Surgery

Original Research Article

# CLINICOPATHOLOGICAL AND RADIOLOGICAL CORRELATION OF THYROID SWELLINGS

**Vimalraj S[1], Tracy Rosalin Poulose[2], Guhan R J[3], Premkumar S[4], Ramprasad R[5]**

[1]Associate Professor, Department of General Surgery, PSG Institute of Medical Sciences & Research, Coimbatore, Tamil Nadu, India.
[2]Associate Professor, Department of General Surgery, PSG Institute of Medical Sciences & Research, Coimbatore, Tamil Nadu, India.
[3]Associate Professor, Department of General Surgery, PSG Institute of Medical Sciences & Research, Coimbatore, Tamil Nadu, India.
[4]Professor, Department of General Surgery, PSG Institute of Medical Sciences & Research, Coimbatore, Tamil Nadu, India.
[5]PG Resident, Department of General Surgery, PSG Institute of Medical Sciences & Research, Coimbatore, Tamil Nadu, India.

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Corresponding Author:
**Dr. Ramprasad R,**
Email: rp1908ngt@gmail.com

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## ABSTRACT

**Background:** Thyroid disease is the most common endocrine disorder globally and affects about 170 million Indians, with the Himalayan belt being one of the main endemic areas. It encompasses a range of diseases from benign goiters to malignant tumors, and benign disease is frequently iodine-deficiency-related. The signs and symptoms are variable depending on the dysfunction and may range from cosmetic deformity to compressive features or systemic features of hyper- or hypothyroidism. The diagnosis is made through a quadruple assessment, including clinical examination, thyroid function tests, ultrasonography, fine-needle aspiration cytology (FNAC), and histopathology, which is the gold standard. The study was conducted to assess the spectrum of thyroid lesions and correlate histopathological findings with clinical, radiological, and cytopathological observations. It also aimed to determine the sensitivity and specificity of neck ultrasonography (ACR TI-RADS) and FNAC in diagnosing thyroid neoplasms. **Materials and Methods:** This was a prospective observational study conducted at the Department of General Surgery of PSGIMSR, Coimbatore, from January 2023 to January 2024 including 56 patients aged between 18 and 70 years who were admitted with thyroid swelling. FNAC was necessary for inclusion, and patients who presented with other midline or lateral neck swellings or who were diagnosed with hyperthyroidism were excluded from the study. The collected data were compiled and analyzed using SPSS version 25. **Results:** Thyroid swellings were most common in the 31–40 and 61–70 years age groups (each 26.8%), with a significant female majority (83.9%, female-to-male ratio 5.2:1). Most patients had swelling for 1–6 months (28.6%) or 1–5 years (23.2%). Diffuse thyroid swellings were the most common presentation (37.5%), followed by right-sided (33.9%) and left-sided (28.6%) swellings. Cervical lymphadenopathy, present in 1.8% of patients, was most often related to papillary carcinoma, emphasizing its clinical importance in malignancy diagnosis. FNAC reported 53.6% of cases as benign, 21.4% as indeterminate, and 21.4% as suspicious or malignant. This shows the significant contribution of FNAC to preoperative diagnosis. Papillary carcinoma was the most common malignancy reported cytologically. Total thyroidectomy was performed in 51.8% of cases and hemithyroidectomy in 48.2%. ACR TI-RADS showed moderate sensitivity (78.9%) but low specificity (40.5%), supporting its role as a risk stratification tool rather than a definitive method for excluding malignancy. FNAC demonstrated higher specificity (87.5%) than sensitivity (75%), indicating excellent accuracy for benign lesions but a lower ability to detect all malignant cases. **Conclusions:** Thyroid swellings predominantly affected females, with nodular colloid goitre being the most common benign lesion and papillary carcinoma the most frequent malignancy. ACR TI-RADS is a valuable initial tool for preoperative risk stratification, whereas FNAC provides greater diagnostic accuracy for distinguishing benign from malignant lesions. The combined use of clinical assessment, ACR TI-RADS, and FNAC enhances diagnostic confidence, facilitates appropriate surgical decision-making, and optimizes the management of thyroid swellings.

## INTRODUCTION

Thyroid disease is the most common endocrine disorder worldwide and constitutes a major public health problem, particularly in iodine-deficient regions.[1,2] In India, thyroid disorders affect nearly 170 million people, with the Himalayan belt remaining an important endemic region for iodine deficiency disorders.[2,3] Thyroid disease encompasses a spectrum of conditions ranging from benign goitres, commonly associated with iodine deficiency,[2,3] to malignant neoplasms. Clinical presentation varies widely, from asymptomatic or cosmetic neck swelling to compressive symptoms or manifestations of thyroid dysfunction.[1,4]

Diagnosis is based on a comprehensive assessment, including clinical examination, thyroid function tests, ultrasonography, fine-needle aspiration cytology (FNAC), and histopathology, which remains the gold standard for definitive diagnosis.[1,4,5] Correlation of clinical, radiological, cytological, and histopathological findings improves diagnostic accuracy and facilitates appropriate management.[1,5]

In India, multinodular goitre remains one of the commonest causes of thyroid enlargement because of longstanding iodine deficiency in several regions.[2,3] Thyroid swellings exhibit variable growth patterns; multinodular goitre, solitary thyroid nodules, papillary carcinoma, and follicular carcinoma usually demonstrate slow progression,[1] whereas anaplastic carcinoma typically presents with rapidly enlarging neck masses and aggressive clinical behaviour.[6] Among thyroid malignancies, papillary thyroid carcinoma accounts for approximately 80–85% of cases, followed by follicular carcinoma (10–15%), medullary carcinoma (3–5%), anaplastic carcinoma (1–2%), and primary thyroid lymphoma (<2%).[6,7]

Evaluation of thyroid swellings includes detailed history taking, physical examination, biochemical investigations, imaging, and histopathological examination.[1,4] Thyroid function tests (T3, T4, and TSH) assess functional status,[1] while serum calcitonin is useful in selected patients with suspected medullary thyroid carcinoma.[4] Ultrasonography is a safe, non-invasive, cost-effective, and highly sensitive imaging modality for evaluating thyroid nodules.[8] It accurately detects multinodularity and multicentricity and is superior to palpation in characterizing thyroid lesions.[8] The American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) standardizes ultrasound reporting and guides decisions regarding FNAC and follow-up.[9]

FNAC is a rapid, minimally invasive, accurate, and cost-effective diagnostic technique for evaluating thyroid nodules.[5] It plays a pivotal role in distinguishing neoplastic from non-neoplastic lesions and in planning appropriate management.[5] Cytological reporting is standardized using the Bethesda System for Reporting Thyroid Cytopathology.[5] Recent advances such as ultrasound elastography, diffusion-weighted magnetic resonance imaging, and molecular testing have further enhanced the diagnostic evaluation of thyroid nodules.[1,10]

The present study aimed to evaluate the spectrum of thyroid lesions and correlate histopathological findings with clinical, radiological, and cytopathological observations. It also sought to determine the prevalence of various pathological lesions presenting as thyroid swellings and assess the diagnostic performance of ultrasonography (ACR TI-RADS) and FNAC using histopathology as the reference standard.

## MATERIALS AND METHODS

This observational study was conducted in the Department of General Surgery at PSG Institute of Medical Sciences and Research (PSGIMSR), Coimbatore, over one year. The study aimed to evaluate the spectrum of thyroid lesions and correlate histopathological findings with clinical, radiological, and cytopathological observations. In addition, the study assessed the relative prevalence of various pathological lesions presenting as thyroid swellings and evaluated the diagnostic performance of ultrasonography using the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) and fine-needle aspiration cytology (FNAC), with histopathological examination serving as the reference standard.

The sample size was calculated using the formula $n = 4pq/d^2$, assuming a prevalence of thyroid nodules of 14%, an allowable error of 10%, and a non-response rate of 15%, resulting in a final sample size of 56 patients.

Patients aged 18–70 years who were clinically diagnosed with thyroid swelling, admitted to the Department of General Surgery, and underwent FNAC were included in the study. Patients with other midline or lateral neck swellings and those diagnosed with hyperthyroidism were excluded.

A detailed clinical history was obtained from all participants, including demographic characteristics, presenting complaints, duration of illness, symptoms suggestive of thyroid dysfunction, previous medical treatment, drug history, and any history of neck surgery or irradiation. All patients underwent comprehensive general, systemic, and local examinations. Local examination included assessment of the size, shape, surface, margins, consistency, mobility, tenderness, movement with deglutition, movement with tongue protrusion, and cervical lymph node status. Based on the clinical findings, a provisional diagnosis was established.

All patients underwent thyroid function tests, ultrasonography of the neck with ACR TI-RADS classification, FNAC reported according to the Bethesda System for Reporting Thyroid Cytopathology, and postoperative histopathological examination. Patients with abnormal thyroid function


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were initially managed medically, and surgery was performed after achieving a euthyroid state.

Neck ultrasonography was performed using a high-frequency linear transducer with real-time colour Doppler imaging. Thyroid nodules were evaluated for composition, echogenicity, margins, calcifications, shape, vascularity, and other sonographic features suggestive of malignancy and were categorized according to the ACR TI-RADS classification.

FNAC was performed under aseptic precautions in the Department of Pathology. Cytological smears were prepared using standard laboratory techniques and reported according to the Bethesda classification. All patients subsequently underwent the appropriate surgical procedure. Resected specimens were fixed in formalin and subjected to histopathological examination, which served as the gold standard for diagnosis. Clinical, radiological, cytopathological, and histopathological findings were correlated to determine the spectrum of thyroid lesions and evaluate the diagnostic accuracy of ultrasonography and FNAC.

The study was approved by the Institutional Human Ethics Committee of PSG Institute of Medical Sciences and Research (Approval Nos. PSG/IHEC/2023/Appr/Exp/278 and PSG/IHEC/2024/Renew/139) and was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before enrolment.

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages. The diagnostic performance of ultrasonography (ACR TI-RADS) and FNAC was evaluated by calculating sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy, using histopathological examination as the reference standard.

## RESULTS

**Table 1: Distribution of age groups in the study population (n=56)**

| Age Category (In Years) | Frequency | Percent |
|---|---|---|
| 21-30 | 7 | 12.5 |
| 31 - 40 | 15 | 26.8 |
| 41 - 50 | 9 | 16.1 |
| 51 - 60 | 10 | 17.9 |
| 61 - 70 | 15 | 26.8 |
| Total | 56 | 100.0 |

Table 1 shows the age distribution of the study participants. Among the 56 patients included in the study, the highest proportion belonged to the 31–40 years and 61–70 years age groups, with 15 patients (26.8%) each. This was followed by the 51–60 years age group (17.9%), 41–50 years age group (16.1%), and 21–30 years age group (12.5%). [Table 1]

**Table 2: Gender Distribution (n=56)**

| Gender | Frequency | Percent |
|---|---|---|
| Male | 9 | 16.1 |
| Female | 47 | 83.9 |
| Total | 56 | 100.0 |

Table 2 shows the gender distribution of the study participants. Of the 56 patients included in the study, 47 (83.9%) were females and 9 (16.1%) were males, yielding a female-to-male ratio of approximately 5.2:1. [Table 2]

**Table 3: Distribution of patients according to the site of thyroid swelling (n = 56)**

| Site of Neck Swelling | Frequency | Percent |
|---|---|---|
| Diffuse | 21 | 37.5 |
| Right | 19 | 33.9 |
| Left | 16 | 28.6 |
| Total | 56 | 100.0 |

Table 3 shows the distribution of patients according to the site of thyroid swelling. Diffuse thyroid swelling was the most frequent presentation (37.5%), followed by right-sided (33.9%) and left-sided (28.6%) thyroid swellings. [Table 3]

**Table 4: Distribution of thyroid swellings according to surface characteristics (n = 56)**

| Surface of swelling | Frequency | Percent |
|---|---|---|
| Smooth | 43 | 76.8 |
| Irregular | 13 | 23.2 |
| Total | 56 | 100.0 |


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Table 4 shows the distribution of thyroid swellings according to surface characteristics. A smooth surface was the predominant clinical finding, observed in 76.8% of thyroid swellings, whereas 23.2% had an irregular surface. [Table 4]

**Table 5: Distribution of patients according to the size of thyroid swelling (n = 56)**

| Size of swelling | Frequency | Percent |
|---|---|---|
| 2-4cm | 18 | 32.1 |
| 4-6cm | 19 | 33.9 |
| >6cm | 19 | 33.9 |
| Total | 56 | 100.0 |

Table 5 shows the distribution of patients according to the size of thyroid swelling. The majority of thyroid swellings measured ≥4 cm, with 4–6 cm and >6 cm lesions each comprising 33.9% of cases. Swellings measuring 2–4 cm accounted for the remaining 32.1%. [Table 5]

**Table 6: Distribution of patients according to the progression of thyroid swelling (n = 56)**

| Progression of size of neck swelling | Frequency | Percent |
|---|---|---|
| Slow | 47 | 83.9 |
| Rapid | 8 | 14.3 |
| Non progressive | 1 | 1.8 |
| Total | 56 | 100.0 |

Table 6 shows the distribution of patients according to the progression of thyroid swelling. Most thyroid swellings showed slow progression (83.9%), while rapid progression and non-progression were observed in 14.3% and 1.8% of cases, respectively. [Table 6]

**Table 7: Distribution of thyroid nodules according to ACR TI-RADS classification (n = 56)**

| ACR TI-RADS | | Frequency | Percent |
|---|---|---|---|
| 1 | Benign | 2 | 3.6 |
| 2 | Not Suspicious | 17 | 30.4 |
| 3 | Mildly Suspicious | 22 | 39.3 |
| 4 | Moderately Suspicious | 12 | 21.4 |
| 5 | Highly Suspicious | 3 | 5.4 |
| Total | | 56 | 100 |

Table 7 shows the distribution of thyroid nodules according to ACR TI-RADS classification. According to the ACR TI-RADS classification, ACR TI-RADS 3 was the most common category, observed in 22 patients (39.3%), followed by ACR TI-RADS 2 in 17 patients (30.4%), ACR TI-RADS 4 in 12 patients (21.4%), ACR TI-RADS 5 in 3 patients (5.4%), and ACR TI-RADS 1 in 2 patients (3.6%). [Table 7]

**FNAC**

In our study, we observed that 53.6% of cases were classified as benign based on FNAC, while 21.4% were considered indeterminate. Suspicious and malignant cases together accounted for 21.4%, underlining the importance of cytological evaluation in thyroid disease diagnosis.

**Table 8: Distribution of FNAC findings according to the Bethesda System for Reporting Thyroid Cytopathology (n = 56)**

| Bethesda Category | Cytological Diagnosis | Frequency | Percent |
|---|---|---|---|
| I | Non diagnostic | 2 | 3.6 |
| II | Benign | 30 | 53.6 |
| III | Atypia of undetermined Significance | 12 | 21.4 |
| IV | Follicular neoplasm | 6 | 10.7 |
| V | Suspected malignancy | 6 | 10.7 |

Table 8 shows the distribution of FNAC findings according to the Bethesda System for Reporting Thyroid cytopathology. Benign cytology (Bethesda II) was the predominant FNAC finding (53.6%), followed by atypia of undetermined significance (Bethesda III) (21.4%). Follicular neoplasm (Bethesda IV) and suspicious for malignancy (Bethesda V) each accounted for 10.7% of cases, while non-diagnostic smears (Bethesda I) constituted 3.6%. [Table 8]


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**Table 9: Diagnostic performance of FNAC using histopathological examination as the reference standard**

| Diagnostic parameter | Value (%) |
|---|---|
| Sensitivity | 75.0 |
| Specificity | 87.5 |
| Positive predictive value (PPV) | 50.0 |
| Negative predictive value (NPV) | 95.5 |
| Overall diagnostic accuracy | 85.7 |

Table 9 shows the diagnostic performance of FNAC using histopathological examination as the reference standard. Using histopathological examination as the reference standard, FNAC showed a sensitivity of 75.0%, specificity of 87.5%, positive predictive value of 50.0%, negative predictive value of 95.5%, and an overall diagnostic accuracy of 85.7%. [Table 10]

**Table 10: Diagnostic performance of ACR TI-RADS using histopathological examination as the reference standard**

| Diagnostic parameter | Value (%) |
|---|---|
| Sensitivity | 78.9 |
| Specificity | 40.5 |
| Positive predictive value (PPV) | 40.5 |
| Negative predictive value (NPV) | 78.9 |
| Overall diagnostic accuracy | 53.6 |

Table 10 shows the diagnostic performance of ACR TI-RADS using histopathological examination as the reference standard. Using histopathological examination as the reference standard, ACR TI-RADS demonstrated a sensitivity of 78.9%, specificity of 40.5%, positive predictive value of 40.5%, negative predictive value of 78.9%, and an overall diagnostic accuracy of 53.6%.

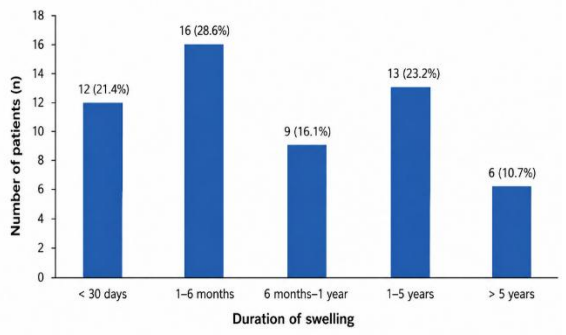


**Figure 1: Duration of Swelling**

Figure 1 shows the distribution of patients according to the duration of thyroid swelling before presentation. Most patients presented with a duration of swelling of 1–6 months (28.6%), followed by 1–5 years (23.2%) and less than 30 days (21.4%). The fewest patients had a duration of swelling exceeding 5 years (10.7%). [Figure 1]

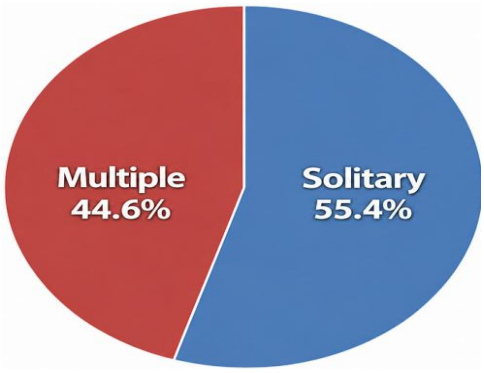


**Figure 2: Distribution of patients according to the number of thyroid nodules**

Figure 2 shows the distribution of patients according to the number of thyroid nodules. Solitary thyroid nodules were observed in 31 patients (55.4%), while multiple nodules were present in 25 patients (44.6%). [Figure 2]


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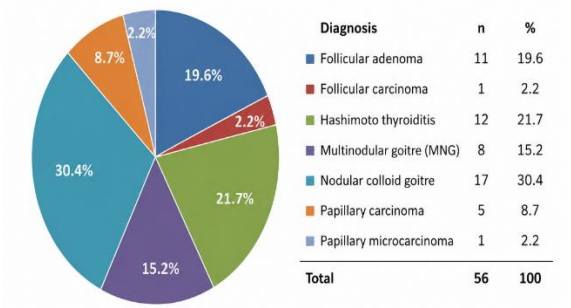
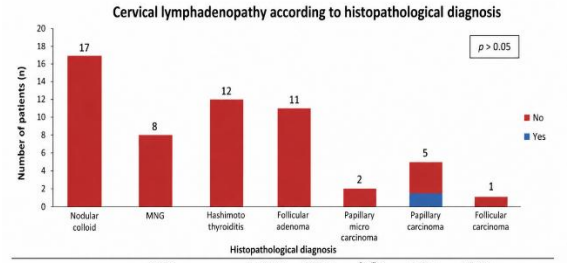



| Diagnosis | n | % |
|---|---|---|
| Follicular adenoma | 11 | 19.6 |
| Follicular carcinoma | 1 | 2.2 |
| Hashimoto thyroiditis | 12 | 21.7 |
| Multinodular goitre (MNG) | 8 | 15.2 |
| Nodular colloid goitre | 17 | 30.4 |
| Papillary carcinoma | 5 | 8.7 |
| Papillary microcarcinoma | 1 | 2.2 |
| Total | 56 | 100 |

**Figure 3: Distribution of histopathological diagnoses among patients with thyroid swelling**

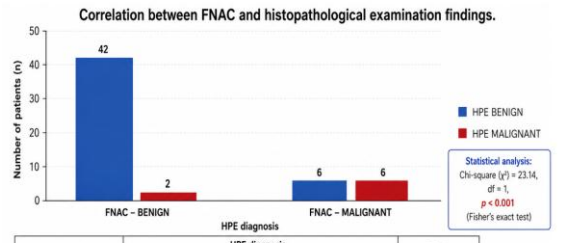
Figure 3 shows the distribution of histopathological diagnoses among patients with thyroid swelling. Nodular colloid goitre was the predominant histopathological diagnosis (30.4%), followed by Hashimoto's thyroiditis (21.7%) and follicular adenoma (19.6%). Multinodular goitre accounted for 15.2% of cases, whereas papillary thyroid carcinoma, follicular carcinoma, and papillary thyroid microcarcinoma together comprised the malignant lesions. [Figure 3]




| Histopathological diagnosis | Nodular colloid (n = 17) | MNG (n = 8) | Hashimoto thyroiditis (n = 12) | Follicular adenoma (n = 11) | Papillary micro carcinoma (n = 2) | Papillary carcinoma (n = 5) | Follicular carcinoma (n = 1) | Total (N = 56) |
|---|---|---|---|---|---|---|---|---|
| Lymphadenopathy present (Yes), n (%) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (20.0) | 0 (0.0) | 1 (1.8) |
| Lymphadenopathy absent (No), n (%) | 17 (100.0) | 8 (100.0) | 12 (100.0) | 11 (100.0) | 2 (100.0) | 4 (80.0) | 1 (100.0) | 55 (98.2) |
| Total, n (%) | 17 (100.0) | 8 (100.0) | 12 (100.0) | 11 (100.0) | 2 (100.0) | 5 (100.0) | 1 (100.0) | 56 (100.0) |

**Figure 4: Distribution of cervical lymphadenopathy according to histopathological diagnosis**

Figure 4 shows the distribution of cervical lymphadenopathy according to histopathological diagnosis. Cervical lymphadenopathy was observed predominantly in patients with papillary thyroid carcinoma, whereas it was uncommon in other histopathological diagnoses. However, no statistically significant association was found between cervical lymphadenopathy and histopathological diagnosis ($p > 0.05$). [Figure 4]




| FNAC diagnosis | HPE diagnosis | | Total n |
|---|---|---|---|
| | HPE BENIGN n (%) | HPE MALIGNANT n (%) | |
| FNAC – BENIGN | 42 (87.5%) | 2 (25.0%) | 44 |
| FNAC – MALIGNANT | 6 (12.5%) | 6 (75.0%) | 12 |
| Total | 48 | 8 | 56 |

**Figure 5: Correlation between FNAC and histopathological examination findings**

Figure 5 shows the correlation between FNAC and histopathological examination findings. Histopathological examination identified 8 malignant and 48 benign lesions. FNAC correctly identified 6 of the 8 malignant lesions and 42 of the 48 benign lesions, with 2 false-negative and 6 false-positive results. [Figure 5]

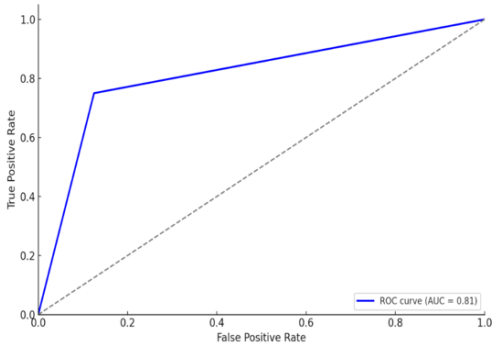
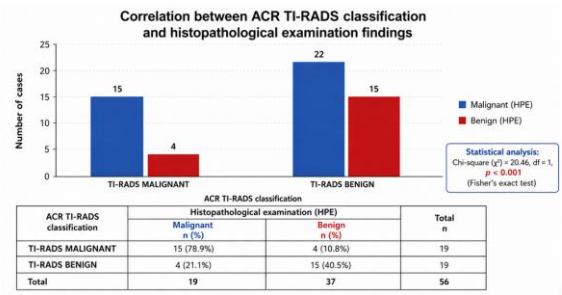



**Figure 6: Receiver operating characteristic (ROC) curve of FNAC for the diagnosis of thyroid malignancy using histopathological examination as the reference standard**

Figure 6 shows the receiver operating characteristic (ROC) curve of FNAC for the diagnosis of thyroid malignancy using histopathological examination as the reference standard. ROC curve analysis showed good diagnostic performance of FNAC, with an area under the curve (AUC) of 0.81 using histopathological examination as the reference standard. [Figure 6]




| ACR TI-RADS classification | Histopathological examination (HPE) | | Total n |
|---|---|---|---|
| | Malignant n (%) | Benign n (%) | |
| TI-RADS MALIGNANT | 15 (78.9%) | 4 (10.8%) | 19 |
| TI-RADS BENIGN | 4 (21.1%) | 15 (40.5%) | 19 |
| Total | 19 | 37 | 56 |

**Figure 7: Correlation between ACR TI-RADS classification and histopathological examination findings**

Figure 7 shows the correlation between ACR TI-RADS classification and histopathological examination findings. Histopathological examination identified 19 malignant and 37 benign lesions. Based on ACR TI-RADS classification, 15 of the 19 malignant lesions and 15 of the 37 benign lesions were correctly classified, with 4 false-negative and 22 false-positive results. [Figure 7]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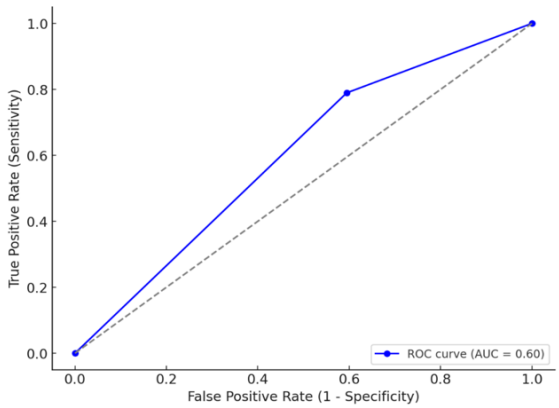


**Figure 8: Receiver operating characteristic (ROC) curve of ACR TI-RADS for the diagnosis of thyroid malignancy using histopathological examination as the reference standard**

Figure 8 shows the receiver operating characteristic (ROC) curve of ACR TI-RADS for the diagnosis of thyroid malignancy using histopathological examination as the reference standard. Receiver operating characteristic (ROC) curve analysis demonstrated limited diagnostic performance of ACR TI-RADS for the detection of thyroid malignancy. The area under the ROC curve (AUC) was 0.60, indicating limited overall discriminatory ability when compared with histopathological examination as the reference standard. [Figure 8]

## DISCUSSION

In our study, the most commonly affected age groups were 31–40 years and 61–70 years, each accounting for 26.8% of the study population. Overall, patients aged <40 years constituted 39.3% of the study population. Patel et al,[11] reported the highest incidence in the fourth decade (32%), while Sengupta et al,[12] found that 75.84% of cases occurred between 20 and 40 years of age. Similarly, Daimary et al,[13] observed that 60.37% of patients were below 40 years, supporting the observation that thyroid swellings commonly affect young and middle-aged adults, although a second peak was observed among older adults in the present study.

Regarding gender distribution, females constituted 83.9% of our study population, with a female-to-male ratio of 5.2:1. This finding is consistent with Patel et al,[11] who reported a female-to-male ratio of 6.14:1, and Daimary et al,[13] who found female predominance in 84.9% of cases. Similar observations by Haque et al,[14] further confirm the well-established female predominance in thyroid disorders.

The duration of swelling ranged widely, with 28.6% of patients presenting within 1–6 months and 23.2% presenting after 1–5 years. Sengupta et al,[12] similarly reported a duration ranging from six months to three years, suggesting that most thyroid swellings are detected within the first few years of onset.

Diffuse thyroid enlargement was the most common presentation in our study (37.5%), followed by right-sided (33.9%) and left-sided (26.8%) unilateral swellings. Sengupta et al,[12] also reported right-lobe predominance, whereas Monika Chaudary et al,[15] observed a higher frequency of left-sided swellings (36%), indicating geographical and population-based variations in lesion distribution.

Histopathological examination revealed nodular colloid goitre as the most common diagnosis (30.4%), followed by Hashimoto's thyroiditis (21.4%) and follicular adenoma (19.6%). Similar findings were reported by Patel et al,[11] who identified colloid goitre (57%) as the predominant benign lesion, followed by nodular goitre (19%). Daimary et al,[13] also reported colloid goitre as the most frequent histopathological diagnosis (62.3%), while Mondal and Das et al,[16] documented colloid goitre in 58% of cases.

Malignancy was identified in 14.3% of patients, with papillary carcinoma accounting for 8.9% of all cases and representing the most common malignant lesion. Patel et al,[11] similarly reported papillary carcinoma as the predominant thyroid malignancy, comprising 65.21% of malignant lesions, while Daimary et al,[13] observed an overall malignancy rate of 13.2%, with papillary carcinoma being the most frequent subtype. These findings reinforce the predominance of papillary carcinoma among thyroid malignancies.

Fine Needle Aspiration Cytology (FNAC) classified 53.6% of nodules as benign, whereas 21.4% were indeterminate and another 21.4% were suspicious or malignant. The overall sensitivity, specificity, and diagnostic accuracy of FNAC were 75%, 87.5%, and 85.7%, respectively. Patel et al,[11] reported corresponding values of 55.6%, 100%, and 91%, respectively. Kaur et al,[17] demonstrated FNAC sensitivity and specificity of 83.3% and 100%, while Warpe et al,[18] reported values of 80% and 98.44%, highlighting the consistently high diagnostic performance of FNAC. Nevertheless, false-negative results may occur, particularly in follicular neoplasms and cystic variants of papillary carcinoma, as noted by Patel et al,[11] and Gupta et al.[19]

Based on ultrasonography, 39.3% of nodules were categorized as ACR TI-RADS 3 (probably benign), whereas 26.8% were classified as ACR TI-RADS 4 and 5 (suspicious and probably malignant). These findings are comparable to those of Najeeb et al,[20] who reported that most thyroid nodules belonged to ACR TI-RADS 2 and 3, with only 3.8% categorized as ACR TI-RADS 5.

Kumar et al,[21] emphasized that malignant thyroid nodules are frequently associated with ultrasonographic features such as irregular margins, microcalcifications, and increased internal vascularity. Similar sonographic characteristics were also observed in our study, supporting the usefulness of these features in malignancy prediction.

Surgically, total thyroidectomy was performed in 51.8% of patients, whereas hemithyroidectomy was performed in 48.2%. Patel et al,[11] reported


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hemithyroidectomy in 70% of patients, while Sengupta et al,[12] found hemithyroidectomy to be the most frequently performed procedure (55.06%), indicating that it remains the preferred surgical approach for benign and indeterminate thyroid lesions.

Regarding postoperative outcomes, Patel et al,[11] reported transient hypocalcaemia in 5% of patients and recurrent laryngeal nerve paresis in 2%. In contrast, no significant postoperative complications were observed in our study, which may reflect differences in surgical expertise, operative techniques, patient selection, or perioperative management.

Cervical lymphadenopathy was observed in only 1.8% of patients and was primarily associated with papillary thyroid carcinoma. This finding is consistent with Daimary et al,[3] who identified cervical lymphadenopathy as an important indicator of thyroid malignancy, particularly papillary carcinoma. Borgohain et al,[22] further demonstrated that lymph node involvement increased the probability of malignancy to 65.71%, underscoring the importance of meticulous preoperative lymph node assessment.

We further evaluated the diagnostic performance of FNAC and the Thyroid Imaging Reporting and Data System (ACR TI-RADS) in detecting thyroid malignancy using histopathological examination as the reference standard. Diagnostic performance was assessed using sensitivity, specificity, and receiver operating characteristic (ROC) curve analysis.

FNAC demonstrated a sensitivity of 75% and specificity of 87.5% in diagnosing thyroid malignancies. These findings indicate excellent specificity for correctly identifying benign lesions while maintaining acceptable sensitivity for detecting malignant nodules. Patel et al,[11] reported FNAC sensitivity and specificity of 85% and 78%, respectively, supporting its reliability in preoperative thyroid nodule assessment. Mondal et al,[16] observed a sensitivity of 88.2% and specificity of 72.6%, whereas Gupta et al,[19] reported values of 89.3% and 77.5%, suggesting that although FNAC demonstrates high sensitivity, specificity may be influenced by diagnostic overlap, particularly in follicular-patterned lesions. Daimary et al,[13] reported a higher specificity of 90%, which the authors attributed to improved sampling techniques and greater cytopathological expertise.

The area under the ROC curve (AUC) for FNAC in our study was 0.81, indicating good overall diagnostic performance in differentiating benign from malignant thyroid nodules. Comparable findings were reported by Aneeta et al,[23] who demonstrated an AUC of 0.83. Warpe et al,[18] reported a slightly lower AUC of 0.79, possibly reflecting diagnostic challenges in follicular lesions, whereas Najeeb et al,[20] reported an AUC of 0.85, further supporting the excellent discriminative ability of FNAC.

ACR TI-RADS demonstrated a sensitivity of 78.9% and specificity of 40.5% in our study. Although its sensitivity was comparable to that of FNAC, the markedly lower specificity indicates a higher false-positive rate, limiting its ability to reliably exclude malignancy when used alone. Kumar et al,[21] reported a sensitivity of 82.3% and specificity of 50.2%, while Kaur et al,[17] observed a similar sensitivity (79%) but higher specificity (58%), suggesting that diagnostic performance may vary depending on radiologist expertise and patient characteristics. In contrast, Srinivas et al,[24] reported an even higher specificity (64%), attributing this to strict adherence to ACR TI-RADS criteria, particularly the evaluation of microcalcifications and nodule margins, which improve malignancy prediction. However, our findings are comparable to those of Chaudhary et al,[15] who reported a specificity of only 42%, indicating that ACR TI-RADS should be interpreted in conjunction with cytological and clinical findings rather than as a standalone diagnostic tool.

The AUC for ACR TI-RADS was 0.60, indicating only modest discriminative ability in differentiating benign from malignant thyroid nodules. These findings are comparable to Kumar et al,[21] who reported an AUC of 0.62. Gupta et al,[19] however, reported an even lower AUC of 0.55, attributing the reduced diagnostic performance to poor specificity in nodules with cystic degeneration and calcifications. Collectively, these findings emphasize that while ACR TI-RADS serves as a valuable initial risk stratification tool, FNAC remains indispensable for definitive preoperative diagnosis.

**Limitations of the Study**

This study has certain limitations. It was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings. Only surgically managed cases with histopathological confirmation were included, introducing potential selection bias. Additionally, interobserver variability in ACR TI-RADS and FNAC interpretation was not assessed, and long-term postoperative outcomes were beyond the scope of this study.

## CONCLUSION

Thyroid swellings in our study predominantly affected females and were most commonly observed in the 31–40 and 61–70 years age groups. Nodular colloid goitre was the most frequent histopathological diagnosis, whereas papillary thyroid carcinoma was the predominant malignant lesion.

Fine-needle aspiration cytology (FNAC) demonstrated good diagnostic performance, with moderate sensitivity, high specificity, and good overall diagnostic accuracy, reaffirming its value as the primary preoperative diagnostic modality for thyroid nodules. In contrast, although the Thyroid


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Imaging Reporting and Data System (ACR TI-RADS) showed acceptable sensitivity for malignancy detection, its relatively low specificity limits its ability to reliably differentiate benign from malignant lesions when used alone.

Overall, our findings support the complementary use of ACR TI-RADS and FNAC, with histopathological examination remaining the gold standard for definitive diagnosis. Integrating clinical assessment, ultrasonographic risk stratification, and cytological evaluation can improve the preoperative diagnosis and management of thyroid swellings while facilitating appropriate surgical decision-making.

**Recommendations**

USG- ACR TI-RADS should be used as the initial imaging modality for risk stratification of thyroid nodules, while FNAC should be performed for nodules with suspicious ultrasonographic features to provide cytological confirmation. The combined use of ACR TI-RADS and FNAC offers greater diagnostic accuracy than either modality alone in the preoperative evaluation of thyroid neoplasms and facilitates appropriate surgical planning. However, histopathological examination remains the gold standard for the definitive diagnosis of thyroid lesions.

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