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DIAGNOSTIC ACCURACY OF FINE NEEDLE ASPIRATION CYTOLOGY IN THYROID SWELLING: A HISTOPATHOLOGICAL CORRELATION STUDY

Dr. Vidyanand Kumar[1], Dr. Raj Kishor Kumar[2]*, Dr. Mukesh Kumar[3], Dr. Gaur Chandra Gorain[4]

[1]Senior Resident, Department of Pathology, Medinirai Medical College and Hospital, Daltonganj, Jharkhand, India
[2]*Senior Resident, Department of Pathology, Phulo Jhano Medical College and Hospital, Dumka, Jharkhand, India
[3]Senior Resident, Department of Community Medicine. Phulo Jhano Medical College and Hospital, Dumka, Jharkhand, India
[4]Junior Resident Academic, Department of Pathology. Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India

***Corresponding Author:** Dr. Raj Kishor Kumar
*Senior Resident, Department of Pathology, Phulo Jhano Medical College and Hospital, Dumka, Jharkhand, India

Abstract-

Introduction- Thyroid swellings are common, with malignancy in 5–15% of cases. Fine Needle Aspiration Cytology (FNAC) is a key diagnostic tool due to its accuracy and cost-effectiveness. However, regional variations necessitate local validation. This study evaluates FNAC's diagnostic accuracy by correlating cytology with histopathology to guide optimal management.

Material and methods- This cross-sectional study was conducted over a period of 15 months after ethical approval. A total of 120 patients with palpable thyroid swellings underwent clinical evaluation, ultrasound, FNAC, and histopathological examination. FNAC smears were reported using the Bethesda System. Statistical analysis assessed the diagnostic accuracy of FNAC compared to histopathological outcomes.

Result- Among 120 patients with thyroid swellings, FNAC revealed 56.7% benign, 13.3% malignant, and others in indeterminate categories. Histopathology confirmed 68.3% benign and 31.7% malignant lesions, with papillary carcinoma as the most common malignancy. FNAC showed high diagnostic performance (sensitivity: 82.4%, specificity: 94.6%, accuracy: 91.7%). Significant concordance with histopathology ($p < 0.001$) underscores FNAC's reliability in preoperative evaluation of thyroid nodules.

Conclusion- FNAC is a reliable, minimally invasive, and cost-effective diagnostic tool for evaluating thyroid swellings. It demonstrates high sensitivity, specificity, and accuracy when compared to histopathology. FNAC aids in early diagnosis, appropriate clinical management, and helps reduce unnecessary surgeries, especially in resource-limited settings. Its diagnostic utility remains invaluable.

Keywords- FNAC, Thyroid Swelling, Nodules, Lesions, Histopathological etc.

Introduction-

Thyroid swellings, commonly referred to as thyroid nodules, are frequently encountered in clinical practice. Their prevalence varies significantly, with detection rates ranging from 4% to 7% through physical examination and up to 67% with the use of high-resolution ultrasonography.[1] Although most thyroid nodules are benign, the key clinical concern is the early identification and exclusion of malignancy, which is found in around 5–15% of nodules depending on factors such as age, gender, geographic region, and radiation exposure.[2] Therefore, precise diagnostic methods are necessary to differentiate malignant from benign lesions and guide appropriate clinical management. Fine Needle Aspiration Cytology (FNAC) has become an indispensable diagnostic tool in the initial assessment of thyroid nodules. It is favored for its simplicity, safety, low cost, and high diagnostic accuracy. FNAC is typically performed as an outpatient procedure, and complications are rare.[3] By providing early insight into the nature of thyroid nodules, FNAC helps avoid unnecessary surgical interventions, especially in benign cases. This is particularly advantageous in low-resource settings where access to more advanced diagnostic tools may be limited.[4] To enhance the consistency and accuracy of FNAC reporting, the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) was introduced in 2007 and updated in 2017. This classification system groups thyroid cytology into six categories, each linked to an estimated risk of malignancy and clinical recommendations.[5,6] By standardizing diagnostic terminology, the Bethesda system has improved communication between cytopathologists and treating physicians, contributing to better patient outcomes.

Nevertheless, FNAC is not without limitations. Issues such as inadequate sample collection, suboptimal smear quality, and subjective interpretation may lead to diagnostic errors. Additionally, follicular neoplasms and Hurthle cell lesions pose significant diagnostic challenges, as cytological examination alone cannot determine capsular or vascular invasion, which is necessary for distinguishing adenomas from carcinomas.[7] Consequently, histopathological analysis of excised tissue remains the definitive diagnostic modality. Research assessing the diagnostic accuracy of FNAC has reported high sensitivity and specificity, with sensitivity typically ranging from 65% to 98% and specificity from 72% to 100% when compared with histopathological outcomes.[8,9] Predictive values may vary based on factors such as the experience of the cytopathologist, institutional protocols, and the characteristics of the nodules being evaluated.[10] Continuous evaluation of FNAC's performance in diverse clinical settings is essential to maintain its diagnostic reliability.

In India, the incidence of thyroid disorders is increasing, largely due to enhanced awareness, improved healthcare access, and the broader use of imaging modalities.[11] FNAC remains a key diagnostic tool in the Indian healthcare system, offering an accessible and economical solution for the evaluation of thyroid lesions. However, there is a need for more region-specific studies that correlate FNAC findings with histopathological diagnoses to assess its effectiveness and identify potential diagnostic challenges in the local context. Hence this study was designed to evaluate the diagnostic accuracy of FNAC in thyroid swellings by comparing cytological results with subsequent histopathological findings. The findings will contribute valuable data toward optimizing the preoperative assessment of thyroid nodules.

Materials and Methods

This cross-sectional study was conducted in the Department of Pathology, Medinirai Medical College and Hospital, Daltonganj, Jharkhand over period of 15-month from January 2024 to March 2025. Ethical clearance was obtained from the Institutional Ethics Committee before commencing the study. Informed consent was obtained from all patients prior to inclusion. Patients of any age and sex, presenting with palpable thyroid swellings and referred for fine needle aspiration cytology (FNAC) were recruited. Nodules confirmed clinically and radiologically by ultrasound were included. Patients with prior thyroid cancer treatment, recurrent malignancies, or insufficient cytological samples were excluded from the study to maintain accuracy.

A total of 120 patients were enrolled through consecutive sampling. Each patient underwent a detailed clinical evaluation, including thyroid function tests and ultrasound imaging to characterize the nodules. FNAC was performed under sterile conditions by trained personnel using a 23- to 25-gauge

needle attached to a syringe. Multiple passes were made to ensure adequate sampling. Aspirated cells were immediately smeared onto glass slides, with some air-dried for May-Grünwald Giemsa staining and others fixed in alcohol for Papanicolaou staining. The cytology samples were interpreted following The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC). This system classifies thyroid cytology into six categories, ranging from nondiagnostic to malignant, providing estimated malignancy risk and guiding clinical management decisions.[5] Surgical intervention was advised based on FNAC results, clinical presentation, and imaging findings. Excised thyroid tissue specimens were fixed in formalin, processed, and stained with hematoxylin and eosin. Histopathological examination was performed by an experienced pathologist blinded to FNAC results, and the histopathology diagnosis served as the reference standard.

FNAC results were compared against histopathological diagnoses to assess diagnostic accuracy. Key statistical measures including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated. Particular attention was given to cases falling into the indeterminate categories of AUS/FLUS and follicular neoplasms, which pose diagnostic challenges in cytology. Data were compiled using Microsoft Excel and analyzed with SPSS software (version 22.0). Descriptive statistics summarized demographic and clinical characteristics. The chi-square test was applied to examine the relationship between cytological and histopathological diagnoses, with statistical significance set at $p < 0.05$.

Result-

A total of 120 patients with thyroid swellings were evaluated in the present study and underwent fine needle aspiration cytology (FNAC) followed by histopathological examination. The majority were females (n = 94, 78.3%), while males comprised 21.7% (n = 26) only, yielding a male-to-female ratio of 1:3.6 as shown in figure 1.

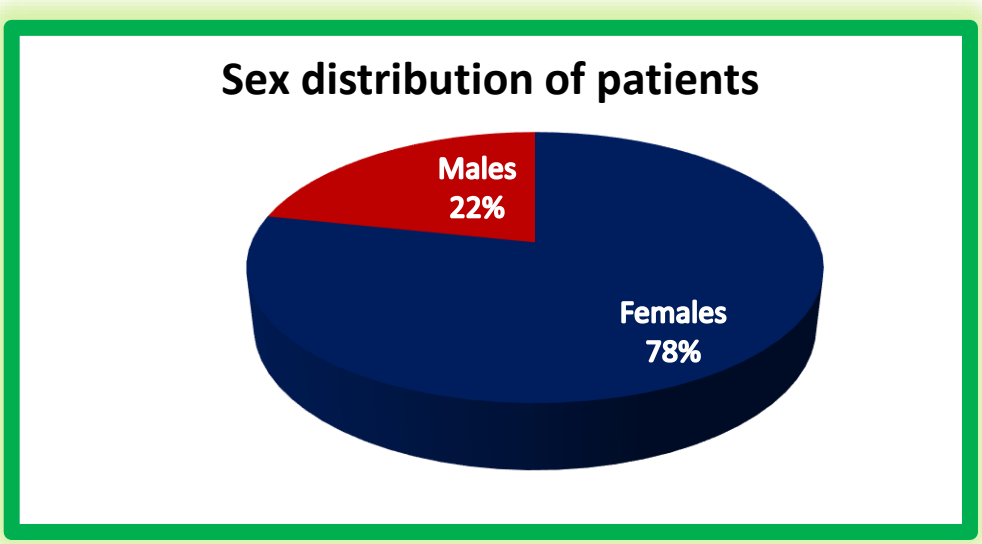

Figure 1- Sex distribution of patients.

The age of the patients ranged from 18 to 75 years, with a mean age of 42.6 ± 12.3 years. In the present study, the majority of thyroid lesion cases were observed in the 31–40 years age group, comprising 38 cases (31.7%). This was followed by 28 cases (23.3%) in the 41–50 years age group and 24 cases (20.0%) in the 21–30 years group. Fewer cases were noted in the 51–60 years group (16 cases; 13.3%) and among individuals older than 60 years (8 cases; 6.7%). The lowest number of cases was seen in the 11–20 years age group, accounting for only 6 cases (5.0%). The age-wise distribution as visible in figure 2 indicated that thyroid lesions were most prevalent among individuals in the third and fourth decades of life.

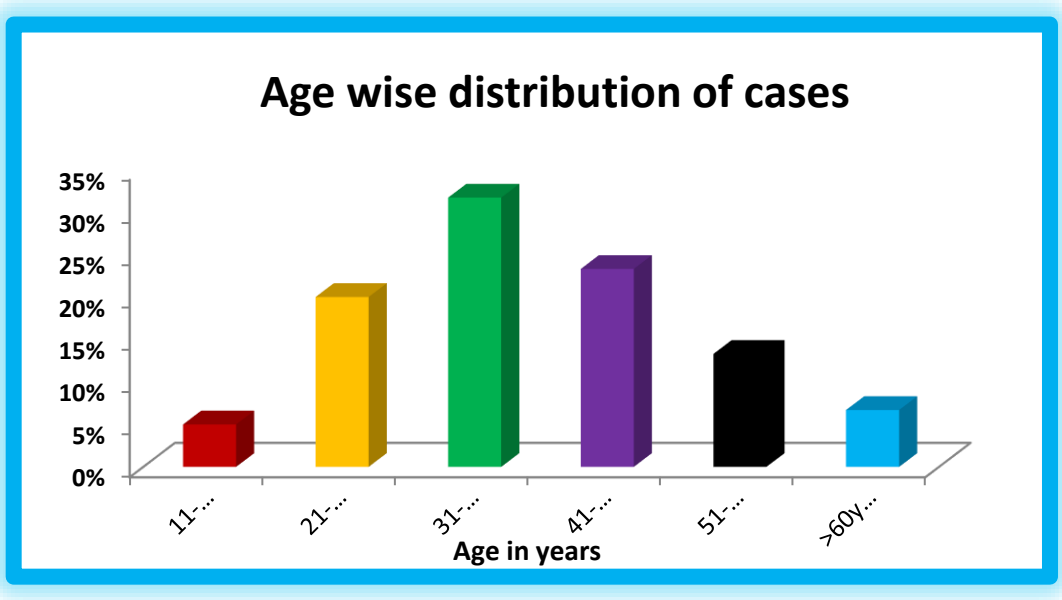

Figure 2- Age-wise distribution of cases

The aspirates obtained from thyroid lesions showed a variety of characteristics as given in table 1. The most common type was thin colloid, observed in 36 cases (30.0%), followed by blood mixed colloid in 22 cases (18.3%) and thick colloid in 18 cases (15.0%). Cellular aspirates with scant colloid accounted for 14 cases (11.7%). Hemorrhagic and blood-only aspirates were seen equally in 10 cases each (8.3%). Clear fluid aspirates were found in 6 cases (5.0%), while purulent aspirates were the least common, observed in 4 cases (3.3%). These findings reflect the diverse nature of thyroid lesion aspirates encountered in clinical practice.

Table 1: Distribution of cases based on nature of aspirate

Nature of Aspirate	n(%)
Thin colloid	36(30.0%)
Thick colloid	18(15.0%)
Blood mixed colloid	22(18.3%)
Cellular with scant colloid	14(11.7%)
Hemorrhagic	10(8.3%)
Purulent	4(3.3%)
Clear fluid	6(5.0%)
Blood only	10(8.3%)

As shown in table 2, clinical examination identified a solitary nodule in 48 cases (40.0%), multinodular goiter in 32 cases (26.7%), diffuse enlargement in 20 cases (16.7%), and no palpable swelling in 20 cases (16.7%). Ultrasonography (USG) detected solitary nodules in 42 cases (35.0%), multinodular goiter in 40 cases (33.3%), diffuse enlargement in 18 cases (15.0%), and no swelling in 20 cases (16.7%). Concordance between clinical and USG findings was observed in 100 cases (83.3%), while discordance was noted in 20 cases (16.7%). Specifically, solitary nodules showed concordance in 36 cases (30.0%) and discordance in 12 cases (10.0%). Multinodular goiter had 28 concordant cases (23.3%) and 12 discordant cases (10.0%). Diffuse enlargement was concordant in 16 cases (13.3%) and discordant in 4 cases (3.3%). No palpable swelling was entirely concordant with USG findings (20 cases; 16.7%). Statistical analysis demonstrated a significant difference between clinical examination and USG in assessing thyroid nodularity ($p = 0.02$), indicating that USG provides valuable additional information and may detect nodules missed on clinical palpation.

Table 2: Comparison of nodularity on clinical examination with ultrasonography (USG) of the thyroid

Nodularity Status	Clinical Examination n(%)	USG Examination n(%)	Concordant Cases n(%)	Discordant Cases n(%)
Solitary nodule	48(40.0%)	42(35.0%)	36(30.0%)	12(10.0%)
Multinodular goiter	32(26.7%)	40(33.3%)	28(23.3%)	12(10.0%)
Diffuse enlargement	20(16.7%)	18(15.0%)	16(13.3%)	4(3.3%)
No palpable swelling	20(16.7%)	20(16.7%)	20(16.7%)	0(0.0%)
Total	**120(100%)**	**120(100%)**	**100(83.3%)**	**20(16.7%)**
p-value---0.02				

As seen in table 3, based on FNAC findings, cases were classified according to the Bethesda System. The majority of cases fell under Bethesda Category II (Benign), comprising 68 cases (56.7%). This was followed by Category VI (Malignant) with 16 cases (13.3%), and Category IV (Follicular neoplasm/suspicious for follicular neoplasm) with 12 cases (10.0%). Category III (AUS/FLUS) accounted for 10 cases (8.3%), while Category V (Suspicious for malignancy) comprised 8 cases (6.7%). A smaller proportion of cases, 6 (5.0%), were classified as Category I (Non-diagnostic/Unsatisfactory). These findings indicate that the majority of thyroid lesions evaluated were cytologically benign, with a substantial proportion also classified as malignant or suspicious.

Table 3- FNAC categorization based on Bethesda System

Bethesda Category	n(%)
I – Non-diagnostic/Unsatisfactory	6(5.0%)
II – Benign	68(56.7%)
III – AUS/FLUS	10(8.3%)
IV – Follicular neoplasm/suspicious	12(10.0%)
V – Suspicious for malignancy	8(6.7%)
VI – Malignant	16(13.3%)

Out of the 120 thyroid lesion cases examined, the majority were benign, accounting for 82 cases (68.3%), while 38 cases (31.7%) were malignant. Among the benign lesions, colloid goiter was the most prevalent, observed in 44 cases (36.7%). This was followed by follicular adenoma in 22 cases (18.3%) and Hashimoto thyroiditis in 16 cases (13.3%). Among the malignant lesions, papillary carcinoma was the most common subtype, found in 30 cases (25.0%). Other malignant subtypes included follicular carcinoma in 5 cases (4.2%), medullary carcinoma in 2 cases (1.7%), and anaplastic carcinoma in 1 case (0.8%). The findings of table 4, highlight that benign thyroid lesions, particularly colloid goiter, were more frequently encountered, while papillary carcinoma was the dominant type among the malignancies.

Table 4- Histopathological Diagnosis

Lesion Type		**n(%)**
Total Benign		82(68.3%)
Total Malignant		38(31.7%)
Subtype of Benign	Colloid goiter	44(36.7%)
	Hashimoto thyroiditis	16(13.3%)
	Follicular adenoma	22(18.3%)
Subtype of Malignant	Papillary carcinoma	30(25.0%)
	Follicular carcinoma	5(4.2%)
	Medullary carcinoma	2(1.7%)
	Anaplastic carcinoma	1(0.8%)

A significant correlation was observed between FNAC results and histopathological diagnosis ($p < 0.001$). Among cases reported as benign on FNAC (Bethesda Category II), 62 cases (51.7%) were confirmed benign by histopathology, while 6 cases (5.0%) were found to be malignant. In the malignant FNAC group (Bethesda Categories V and VI), 28 cases (23.3%) were confirmed malignant on histopathology, with 4 cases (3.3%) identified as benign. Cases classified under other Bethesda categories (I, III, IV) showed 16 benign cases (13.3%) and 6 malignant cases (5.0%) on histopathology. Overall, the findings of table 5, demonstrate a strong concordance between FNAC and histopathological diagnosis, supporting the reliability of FNAC in preoperative evaluation of thyroid lesions.

Table 5-Correlation between FNAC and histopathology

FNAC Result	**Histopathology Benign n (%)**	**Histopathology Malignant n (%)**	**p-value**
Benign (II)	62(51.7%)	6(5.0%)	**< 0.001**
Malignant (V & VI)	4(3.3%)	28(23.3%)	
Others (I, III, IV)	16(13.3%)	6(5.0%)	
Total	**82(68.3%)**	**40(31.7%)**	

Table 6 clearly shows that the FNAC demonstrated high diagnostic efficacy in the evaluation of thyroid lesions. The sensitivity of FNAC was 82.4%, indicating its ability to correctly identify malignant cases. Specificity was higher at 94.6%, reflecting its accuracy in correctly identifying benign cases. The positive predictive value (PPV) was 87.5%, and the negative predictive value (NPV) was 92.1%, showing strong predictive reliability of FNAC results. Overall, the diagnostic accuracy of FNAC was 91.7%, supporting its role as a reliable and valuable tool in the preoperative assessment of thyroid nodules.

Table 6- Diagnostic performance of FNAC

Parameter	**Value**
Sensitivity	82.4%
Specificity	94.6%
Positive Predictive Value (PPV)	87.5%
Negative Predictive Value (NPV)	92.1%
Diagnostic Accuracy	91.7%

Discussion-

This study evaluated the clinicopathological profile of thyroid lesions in 120 patients, focusing on FNAC and histopathological correlation. The demographic findings revealed a predominance of females (78.3%) with a female-to-male ratio of 3.6:1, consistent with the well-established higher

prevalence of thyroid disorders in females. This aligns with previous research by Goyal et al.[12] and Singh et al.[13], who reported female predominance with ratios ranging from 3:1 to 5:1, highlighting the gender predisposition possibly related to hormonal influences on thyroid tissue. The age distribution showed most cases in the 31–40 years group (31.7%), followed by the 41–50 and 21–30 years groups. This age range corresponds with the peak incidence of thyroid nodules in middle-aged adults as documented by Das et al.[14] and Li et al.[15], emphasizing the importance of focused screening and evaluation in this demographic.

The nature of aspirates was diverse, with thin colloid being most common (30%), followed by blood mixed colloid (18.3%) and thick colloid (15%). This distribution is comparable to findings by Sharma et al.[16], who also noted colloid-rich aspirates as typical in benign thyroid lesions, particularly colloid goiter. The presence of hemorrhagic and blood-only aspirates in nearly 16.6% of cases could be attributed to vascularity and lesion characteristics, as reported by Khan et al.[17], where hemorrhagic aspirates were more frequent in malignancies and hypervascular nodules. Clinical examination identified solitary nodules in 40% of patients, with multinodular goiter and diffuse enlargement following at 26.7% and 16.7%, respectively. Ultrasonography (USG) findings were largely concordant with clinical findings (83.3%), though USG detected more multinodular goiters (33.3%) compared to clinical examination (26.7%). The significant difference between clinical and USG assessment ($p = 0.02$) underscores the value of imaging in thyroid evaluation, consistent with observations by Rahman et al.[18] and Lee et al.[19], who reported USG as a more sensitive tool for detecting smaller or multiple nodules missed on palpation.

The cytological diagnosis according to the Bethesda system showed a predominance of benign lesions (56.7% Bethesda II), with malignant cases (Bethesda VI) accounting for 13.3%. This distribution aligns with studies by Cibas and Ali[20] and Al-Jabr et al.[21], who also observed benign lesions as the majority but emphasized the critical role of Bethesda categorization in risk stratification. The 5.0% rate of non-diagnostic samples (Bethesda I) was within the acceptable range, comparable to international benchmarks and underscoring the technical adequacy of FNAC in this study.[9] Histopathologically, benign lesions constituted 68.3%, with colloid goiter being the most prevalent benign diagnosis (36.7%), followed by follicular adenoma (18.3%) and Hashimoto thyroiditis (13.3%). Malignant lesions accounted for 31.7%, predominantly papillary carcinoma (25%). These findings correlate well with multiple regional and international studies by Gupta et al.[22] and Wang et al.[23], where colloid goiter and papillary carcinoma were the most frequent benign and malignant diagnoses, respectively. The strong correlation between FNAC and histopathology ($p<0.001$) emphasizes FNAC's reliability in preoperative diagnosis. Sensitivity (82.4%) and specificity (94.6%) values in this study are consistent with previous meta-analyses by Bongiovanni et al.[24] and Wang et al.[25], which reported sensitivity ranging between 65-85% and specificity above 90%. The positive predictive value (87.5%) and negative predictive value (92.1%) further support FNAC as a dependable screening tool that effectively distinguishes malignant from benign lesions, guiding clinical management and avoiding unnecessary surgery. The diagnostic accuracy of 91.7% in this study is comparable to other large cohort studies, such as those by Yassa et al.[26] and Moon et al.[27], confirming FNAC's role as a cornerstone in thyroid nodule evaluation. However, the presence of some discordant cases, particularly false negatives and false positives, highlights the limitations of cytology in certain follicular lesions and underscores the need for adjunct molecular testing or core needle biopsy in equivocal cases, as suggested by recent guidelines.[28]

Conclusion-

This study reaffirms the diagnostic importance of FNAC, especially when combined with imaging modalities like ultrasonography, in evaluating thyroid lesions. Thyroid swellings were found to be more common in females in their third and fourth decades, with colloid goiter as the most frequent benign lesion and papillary carcinoma as the predominant malignancy. FNAC demonstrated high sensitivity, specificity, and diagnostic accuracy, making it a reliable, minimally invasive, and cost-effective tool for differentiating benign from malignant lesions. The strong correlation between FNAC and histopathology further supports its use in guiding clinical and surgical decisions. While FNAC is

highly effective, indeterminate or non-diagnostic cases require careful evaluation and follow-up. Recognizing demographic and lesion patterns aids in risk stratification and personalized care. Overall, FNAC remains a cornerstone in the diagnostic approach to thyroid nodules, and future research integrating molecular markers may enhance diagnostic clarity, particularly for ambiguous cases.

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