

ROLE OF FINE NEEDLE ASPIRATION CYTOLOGY IN THE DIAGNOSIS OF THYROID LESIONS: A CLINICOPATHOLOGICAL STUDY

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ABSTRACT

Background: Thyroid nodules are common clinical entities, with a small but significant proportion harboring malignancy. Fine Needle Aspiration Cytology (FNAC) is widely used as an initial diagnostic tool due to its simplicity, safety, and cost-effectiveness. However, its diagnostic accuracy varies across different settings, necessitating institution-specific evaluation.

Objectives: To assess the role of FNAC in the diagnosis of thyroid lesions and to evaluate its diagnostic accuracy by correlating cytological findings with histopathological examination.

Methods: A hospital-based observational cross-sectional study was conducted at a tertiary care hospital in Bihar from March 2022 to December 2022. A total of 62 patients presenting with thyroid swelling were included. FNAC was performed in all cases and reported using the Bethesda System for Reporting Thyroid Cytopathology. Histopathological correlation was available in 38 cases. Diagnostic accuracy parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated. Statistical analysis was performed using SPSS version 25.0, with $p < 0.05$ considered statistically significant.

Results: The majority of patients were females (77.4%) and belonged to the 31–40 years age group. Benign lesions were the most common finding on FNAC (64.5%). Histopathological correlation revealed 28 benign and 10 malignant cases. FNAC showed a sensitivity of 80.0%, specificity of 92.9%, PPV of 80.0%, NPV of 92.9%, and overall diagnostic accuracy of 89.5%. A small number of false-negative and false-positive cases were observed.

Conclusion: FNAC is an effective and reliable diagnostic tool for evaluating thyroid lesions, with high specificity and good overall accuracy. It plays a crucial role in reducing unnecessary surgeries and guiding appropriate management, particularly in resource-constrained settings.

Keywords: Thyroid nodule; FNAC; Bethesda system; Cytology; Histopathology; Diagnostic accuracy

INTRODUCTION

Thyroid nodules are a common clinical finding worldwide, with a prevalence of 4–7% on palpation and up to 50–60% when detected incidentally on ultrasonography [1]. Although most thyroid nodules are benign, the primary clinical concern is to exclude malignancy, which occurs in approximately 5–15% of cases [2]. Thyroid cancer represents the most common endocrine malignancy globally, with an increasing incidence over the past few decades, partly due to improved diagnostic techniques and widespread imaging [3].

Fine Needle Aspiration Cytology (FNAC) has emerged as a cornerstone in the initial evaluation of thyroid nodules due to its simplicity, cost-effectiveness, and high diagnostic accuracy. Introduced in the mid-20th century, FNAC has significantly reduced the need for unnecessary surgical interventions in benign lesions while facilitating timely management of malignant cases [4]. The adoption of standardized reporting systems, such as the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC), has further enhanced the reproducibility and clinical utility of FNAC by categorizing lesions based on their risk of malignancy [5].

In developing countries like India, thyroid disorders constitute a significant public health burden, particularly in regions with iodine deficiency and limited healthcare access [6]. Epidemiological studies indicate that thyroid nodules are increasingly being detected in both urban and rural populations, with a higher prevalence among women and older individuals [7]. Bihar, a state with diverse socio-economic and healthcare challenges, presents a unique setting where cost-effective and minimally invasive diagnostic tools like FNAC play a crucial role in clinical decision-making.

Despite its widespread use, FNAC has certain limitations, including indeterminate results, sampling errors, and difficulty in distinguishing between follicular adenoma and carcinoma due to the need for histopathological evidence of capsular or vascular invasion [8]. Furthermore, variability in diagnostic accuracy may arise due to differences in expertise, technique, and interpretation. Therefore, correlating cytological findings with histopathological outcomes remains essential to validate the effectiveness of FNAC in specific institutional settings.

Several studies conducted across India and globally have demonstrated high sensitivity and specificity of FNAC in diagnosing thyroid lesions; however, variations exist depending on population characteristics and study design [9,10]. There is a need for region-specific clinicopathological studies to assess the diagnostic performance of FNAC and identify potential discrepancies in cytological interpretation.

In this context, the present study was undertaken at a tertiary care hospital in Bihar to evaluate the role of FNAC in the diagnosis of thyroid lesions by correlating cytological findings with histopathological examination wherever available. The aim of the study is to assess the diagnostic accuracy of FNAC and its effectiveness as a primary investigative tool in the management of thyroid nodules.

METHODOLOGY

Study Design: This was a hospital-based observational cross-sectional study with clinicopathological correlation conducted to evaluate the diagnostic role of Fine Needle Aspiration Cytology (FNAC) in thyroid lesions.

Study Setting: The study was conducted in the Departments of Pathology and General Surgery at a tertiary care hospital in Bihar, India, where patients with thyroid swellings are routinely evaluated and managed.

Study Duration: The study was carried out over a period of 10 months, from March 2022 to December 2022.

Study Population: The study population included all patients presenting with clinically palpable thyroid swelling who underwent FNAC during the study period. Patients who subsequently underwent surgical intervention were included for cyto-histopathological correlation.

Inclusion Criteria

- Patients of all age groups and both sexes presenting with thyroid swelling
- Patients who underwent FNAC for thyroid lesions
- Patients who provided informed consent for participation
- Patients who underwent surgical excision with available histopathological reports (for correlation)

Exclusion Criteria

- Patients with non-thyroid neck swellings
- Patients with recurrent thyroid malignancy already diagnosed
- Patients unwilling to participate or not providing consent
- Inadequate or unsatisfactory FNAC samples (as per Bethesda criteria)

Sample Size: A total of 62 patients were included in the study. The sample size was determined based on the number of eligible cases presenting during the study period, considering feasibility and time constraints, which is acceptable for institutional clinicopathological studies.

Sampling Technique: A consecutive sampling technique was used, wherein all eligible patients presenting during the study period were included until the desired sample size was achieved.

Data Collection Tools & Procedure: After obtaining informed consent, detailed clinical history and demographic information were recorded using a predesigned semi-structured proforma. FNAC was performed using a 22–23 gauge needle attached to a 10 mL syringe under aseptic precautions. Smears were prepared, air-dried, and alcohol-fixed, followed by staining with May-Grünwald-Giemsa (MGG) and Papanicolaou (Pap) stains. Cytological diagnosis was reported according to the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC). Patients who underwent thyroid surgery had their specimens subjected to routine histopathological examination using hematoxylin and eosin staining. Cytological findings were then correlated with histopathological diagnoses wherever available.

Study Variables: Independent variables included demographic factors (age, sex), clinical characteristics (duration of swelling, clinical diagnosis), and cytological findings based on FNAC. The dependent variable was the final diagnosis of thyroid lesions, confirmed by histopathological examination. Diagnostic accuracy parameters such as sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were also considered outcome measures.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used to summarize the data. Diagnostic accuracy of FNAC was assessed by calculating sensitivity, specificity, PPV, and NPV using histopathology as the gold standard. The chi-square test or Fisher's exact test was applied to assess associations between categorical variables. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from all participants prior to inclusion in the study. Confidentiality of patient information was strictly maintained. The study adhered to the ethical principles outlined in the Declaration of Helsinki for biomedical research involving human participants.

RESULTS

A total of 62 patients presenting with thyroid swelling were included in the study. The majority of patients were in the 31–40 years age group, accounting for 29.0% of cases (Table 1).

Table 1: Age-wise Distribution of Study Participants (n = 62)

Age Group (years)	Frequency (n)	Percentage (%)
<20	6	9.7
21–30	14	22.5
31–40	18	29.0
41–50	12	19.4
>50	12	19.4
Total	62	100

A marked female predominance was observed, with females constituting 77.4% of the study population (Table 2).

Table 2: Gender Distribution of Study Participants (n = 62)

Gender	Frequency (n)	Percentage (%)
Male	14	22.6
Female	48	77.4
Total	62	100

Based on FNAC findings categorized using the Bethesda system, benign lesions (Category II) were the most common, comprising 64.5% of cases, followed by follicular neoplasm/suspicious lesions (9.7%) and atypia of undetermined significance (8.0%). Malignant lesions (Category VI) accounted for 6.5% of cases (Table 3).

Table 3: Distribution of Thyroid Lesions Based on FNAC (Bethesda Categories) (n = 62)

Bethesda Category	Diagnosis Category	Frequency (n)	Percentage (%)
I	Non-diagnostic/Unsatisfactory	4	6.5

II	Benign lesions	40	64.5
III	Atypia of undetermined significance (AUS)	5	8.0
IV	Follicular neoplasm/suspicious	6	9.7
V	Suspicious for malignancy	3	4.8
VI	Malignant	4	6.5
Total		62	100

Out of 62 cases, 38 patients underwent surgical intervention and were available for cyto-histopathological correlation. Among these, 28 cases were benign and 10 were malignant on histopathology. FNAC correctly identified 26 benign and 8 malignant cases. There were 2 false-negative and 2 false-positive cases (Table 4).

Table 4: Cyto-Histopathological Correlation of Thyroid Lesions (n = 38)

FNAC Diagnosis	Histopathology Benign	Histopathology Malignant	Total
Benign	26	2	28
Suspicious/Malignant	2	8	10
Total	28	10	38

The diagnostic performance of FNAC showed a sensitivity of 80.0% and specificity of 92.9%. The positive predictive value and negative predictive value were 80.0% and 92.9%, respectively. The overall diagnostic accuracy of FNAC in this study was 89.5% (Table 5).

Table 5: Diagnostic Accuracy of FNAC in Thyroid Lesions (n = 38)

Parameter	Value (%)
Sensitivity	80.0
Specificity	92.9
Positive Predictive Value	80.0
Negative Predictive Value	92.9
Diagnostic Accuracy	89.5

DISCUSSION

The present study evaluated the role of Fine Needle Aspiration Cytology (FNAC) in the diagnosis of thyroid lesions with cyto-histopathological correlation in a tertiary care setting. The findings demonstrated that FNAC is a reliable, minimally invasive diagnostic tool with high specificity (92.9%) and good overall diagnostic accuracy (89.5%), although sensitivity (80.0%) was relatively lower due to a small number of false-negative cases.

The demographic profile of the study showed a predominance of patients in the third and fourth decades of life, with a peak incidence in the 31–40 years age group. This observation is consistent with previous studies that have reported higher occurrence of thyroid nodules in middle-aged individuals [2,9]. The marked female preponderance (77.4%) observed in this study aligns with established literature, which attributes the higher incidence of thyroid disorders in females to hormonal influences and autoimmune predisposition [6,7].

In terms of cytological diagnosis, the majority of cases were classified as benign (64.5%) under Bethesda Category II. This is in agreement with earlier studies that have consistently reported benign lesions as the most frequent finding in thyroid FNAC [9,10]. The proportion of indeterminate categories (Bethesda III and IV) in the present study was within acceptable limits and comparable to published data. A meta-analysis by Bongiovanni et al. reported that indeterminate categories constitute a variable but clinically significant proportion of cases, reflecting inherent diagnostic limitations of cytology in follicular-patterned lesions [11].

Cyto-histopathological correlation, available in 38 cases, revealed that FNAC correctly identified most benign and malignant lesions, with only a few discordant cases. The occurrence of false-negative results can be attributed to sampling errors, especially in cases with heterogeneous lesions or cystic changes, while false-positive cases may arise due to overlapping cytological features between hyperplastic nodules and neoplastic lesions [8]. These findings emphasize the importance of adequate sampling and multidisciplinary evaluation.

The sensitivity (80.0%) and specificity (92.9%) observed in this study are comparable to those reported in previous Indian and international studies. Bagga and Mahajan reported sensitivity and specificity values of 83% and 92%, respectively [9], while Gupta et al. observed values of 80% and 95%, respectively [10]. Furthermore, a study by Yassa et al. demonstrated that a multidisciplinary approach incorporating FNAC significantly improves diagnostic accuracy and reduces unnecessary surgeries, supporting the findings of the present study [12].

The relatively high specificity in this study indicates that FNAC is particularly effective in correctly identifying benign lesions, thereby reducing unnecessary surgical interventions. This has significant clinical implications, especially in resource-limited settings like Bihar, where access to advanced diagnostic modalities may be constrained. FNAC serves as a cost-effective and efficient screening tool, aiding clinicians in decision-making and optimizing patient management.

From a public health perspective, early and accurate diagnosis of thyroid lesions is crucial for timely intervention and improved patient outcomes. The use of standardized reporting systems such as the Bethesda system enhances communication between pathologists and clinicians, leading to better risk stratification and management planning [5].

The strengths of the present study include its clinicopathological correlation and use of a standardized reporting system, which improves the validity and comparability of findings. However, certain limitations must be acknowledged. The relatively small sample size and single-center design may limit the generalizability of the results. Additionally, histopathological correlation was available only in a subset of cases, which may introduce selection bias. Interobserver variability in cytological interpretation was not assessed.

Future studies with larger sample sizes and multicentric designs are recommended to further validate the diagnostic performance of FNAC and explore the role of adjunctive techniques such as ultrasound-guided FNAC and molecular testing in improving diagnostic accuracy.

CONCLUSION

The present study demonstrates that Fine Needle Aspiration Cytology (FNAC) is a reliable, safe, and cost-effective diagnostic modality for the initial evaluation of thyroid lesions. The high specificity and overall diagnostic accuracy observed in this study highlight its effectiveness in differentiating benign from malignant lesions, thereby guiding appropriate clinical management. Although sensitivity was comparatively lower due to a few false-negative cases, FNAC remains a valuable first-line investigation, particularly in resource-limited settings. The use of standardized reporting systems such as the Bethesda System enhances diagnostic consistency and facilitates better communication between clinicians and pathologists. However, limitations such as indeterminate categories and sampling errors necessitate careful interpretation and, where required, histopathological confirmation. It is recommended that FNAC be routinely used in the evaluation of thyroid nodules, with emphasis on adequate sampling and expert cytological interpretation. Further large-scale and multicentric studies incorporating adjunctive diagnostic modalities may help improve diagnostic precision and patient outcomes.

DECLARATIONS

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Conflict of Interest: The authors declare no conflict of interest.

Consent: Written informed consent was obtained from all participants prior to inclusion in the study.

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