Section: Pathology

Original Research Article

COMPARISON OF HISTOPATHOLOGY VERSUS FINE NEEDLE ASPIRATION CYTOLOGY (FNAC) BY BETHESDA SYSTEM IN THYROID NODULES: A RETROSPECTIVE STUDY

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ABSTRACT

Background: Thyroid nodules are a common clinical entity, with a small but significant risk of malignancy requiring accurate preoperative diagnosis. Fine Needle Aspiration Cytology (FNAC), reported using the Bethesda System, is commonly used as an initial diagnostic tool, while histopathology remains the gold standard. Therefore, this study aims to compare FNAC findings with histopathological diagnosis and evaluate its diagnostic performance. **Materials and Methods:** This retrospective study included 100 patients with thyroid nodules who underwent FNAC followed by surgical excision between 2018 and 2022. FNAC results were classified using the Bethesda System for Reporting Thyroid Cytopathology. Histopathological examination was considered the gold standard. Diagnostic parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated. **Results:** In the present study, 100 cases were analysed. FNAC identified 65% cases as benign and 7% as malignant. Additionally, 20% of cases were reported as follicular neoplasm, 6% as suspicious for malignancy, and 2% showed atypia of undetermined significance. Histopathological examination revealed 81% benign and 19% malignant lesions. Follicular adenoma was the most common benign lesion, whereas papillary carcinoma predominated among malignancies. The risk of malignancy increased across higher Bethesda categories. FNAC showed a sensitivity of 68.4%, specificity of 96.8%, PPV of 68.4%, NPV of 92.6%, and an overall accuracy of 81%. Concordance between FNAC and histopathology was observed in 93% of cases, with 7% discordance, mainly in follicular-patterned lesions. **Conclusion:** FNAC using the Bethesda system is a reliable, minimally invasive diagnostic tool with high specificity and accuracy for evaluating thyroid nodules. However, it should be used along with clinical findings and histopathology to confirm accurate diagnosis and better patient care.

INTRODUCTION

Thyroid nodules represent a common endocrine abnormality encountered in clinical practice, with prevalence increasing due to widespread use of imaging modalities. Although most thyroid nodules are benign, a small but clinically significant proportion harbor malignancy, necessitating accurate and timely diagnosis. The differentiation between benign and malignant thyroid lesions is crucial in guiding appropriate clinical management and avoiding unnecessary surgical interventions. Therefore, reliable diagnostic tools are essential to stratify patients effectively.[1,2]

Fine Needle Aspiration Cytology (FNAC) has emerged as the primary initial diagnostic modality for evaluating thyroid nodules due to its simplicity, cost-effectiveness, minimal invasiveness, and high patient acceptance. FNAC provides rapid cytological assessment and aids clinicians in decision-making regarding further management. However, interpretation variability and overlap in cytological features, particularly in follicular-patterned lesions, remain diagnostic challenges. To overcome these limitations, the Bethesda System for

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Reporting Thyroid Cytopathology (TBSRTC) was introduced to standardize reporting, improve communication among clinicians, and provide an implied risk of malignancy for each diagnostic category.[3,4]

The Bethesda system classifies thyroid cytology into six categories: non-diagnostic, benign, atypia of undetermined significance (AUS), follicular neoplasm, suspicious for malignancy, and malignant. Each category is associated with a specific risk of malignancy and recommended clinical management. This structured approach has enhanced reproducibility and diagnostic accuracy; however, certain categories such as AUS and follicular neoplasm continue to present interpretative dilemmas, often requiring histopathological confirmation.[5,6]

Histopathological examination remains the gold standard for definitive diagnosis of thyroid lesions. It allows evaluation of architectural patterns, capsular and vascular invasion, and other features that cannot be assessed on cytology alone. Particularly in follicular lesions, histopathology plays a decisive role in distinguishing benign adenomas from malignant carcinomas. Therefore, correlation between FNAC findings and histopathological diagnosis is essential to assess the diagnostic reliability of FNAC.[7,8]

Despite the widespread use of FNAC, discrepancies between cytological and histopathological findings are reported in study. False-negative and false-positive results may occur due to sampling errors, interpretative limitations, or overlapping cytological features. Such discrepancies can lead to misdiagnosis, affecting patient management and outcomes. Hence, evaluating the diagnostic performance of FNAC using parameters such as sensitivity, specificity, predictive values, and accuracy is necessary.[9]

Rafi M, et. al; 2024, compared FNAC results categorized by the Bethesda system with histopathological findings in thyroid nodules. Additionally, it seeks to evaluate the diagnostic efficacy of FNAC and determine its concordance with histopathology. By analyzing these parameters, the study intends to highlighted the strengths and limitations of FNAC, particularly in challenging diagnostic categories.[10,11]

Understanding the correlation between cytological and histopathological findings is vital for improving diagnostic strategies and optimizing patient care. The study also emphasized the importance of integrating FNAC results with clinical and radiological findings for comprehensive evaluation. Ultimately, this study contributes to strengthening the role of FNAC as a frontline diagnostic tool while reinforcing the necessity of histopathological confirmation in selected cases.[12]

The primary aim of this retrospective study is to evaluate the diagnostic accuracy of Fine Needle Aspiration Cytology (FNAC) using the Bethesda System in thyroid nodules by comparing cytological findings with histopathological examination, which serves as the gold standard. The objectives of the study are to determine the sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of FNAC; to categorize thyroid lesions according to the Bethesda System for Reporting Thyroid Cytopathology; to assess the concordance and discordance between FNAC and histopathological findings; to identify the distribution of benign and malignant thyroid lesions; and to analyze the limitations and diagnostic challenges of FNAC, particularly in indeterminate categories such as atypia of undetermined significance and follicular neoplasms.

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of Pathology, Dr PABDMMC Amravati Maharashtra, from 2018 to 2022. Ethical approval has been obtained from the Ethical Approval Committee of Dr PABDMMC Amravati Maharashtra.

Study Population

The present retrospective study comprised 100 patients diagnosed with thyroid nodules who underwent Fine Needle Aspiration Cytology followed by surgical excision. Patients of all age groups and both genders were included. Only those cases with complete cytological and histopathological records were considered. Cases with inadequate samples or incomplete clinical data were excluded to ensure accuracy and reliability of diagnostic comparison.

Data Analysis

Data obtained from cytological and histopathological records were systematically analyzed to assess diagnostic performance of FNAC using the Bethesda system. Statistical parameters including sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated. Concordance and discordance rates between FNAC and histopathology were determined. Results were expressed in percentages and tabulated for clear comparison, with histopathology considered the definitive gold standard for diagnosis.

RESULTS

Table 1: Distribution of FNAC Findings (Bethesda Categories)

Category	Number of Cases	Percentage
Benign	65	65%
Malignant	7	7%

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Follicular Neoplasm	20	20%
Suspicious for Malignancy	6	6%
AUS	2	2%
Total	**100**	**100%**

Out of 100 FNAC cases classified by the Bethesda system, the majority were benign (65%), followed by follicular neoplasm (20%), malignant (7%), suspicious for malignancy (6%), and AUS (2%). Overall, benign lesions predominated, while malignant and indeterminate categories constituted a smaller proportion of cases.

Table 2: Histopathological Diagnosis

Diagnosis Type	Number of Cases	Percentage
Benign	81	81%
Malignant	19	19%
Total	**100**	**100%**

Histopathological evaluation of 100 cases revealed that 81% were benign and 19% were malignant. Overall, benign lesions were predominant, with a smaller proportion confirmed as malignant on final diagnosis.

Table 3: Diagnostic Performance of FNAC

Parameter	Value
Sensitivity	68.4%
Specificity	96.8%
PPV	68.4%
NPV	92.6%
Accuracy	81%

FNAC demonstrated a sensitivity of 68.4%, specificity of 96.8%, positive predictive value of 68.4%, and negative predictive value of 92.6%, with an overall diagnostic accuracy of 81%. These findings indicate high specificity and good overall accuracy, with relatively lower sensitivity in detecting true positive cases.

Table 4: Concordance Analysis

Outcome	Cases	Percentage
Concordant	93	93%
Discordant	7	7%

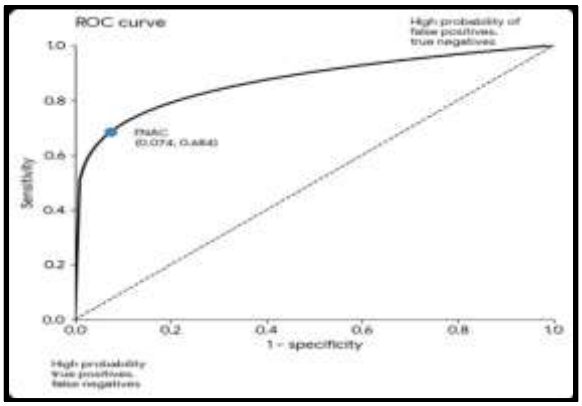

Figure 1: Diagnostic Performance of FNAC Compared with Histopathology

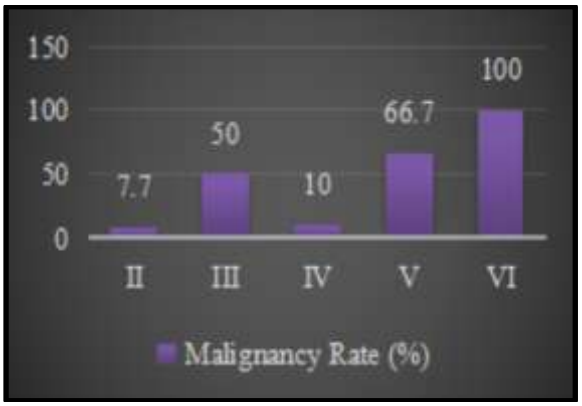

Figure 2: Risk of Malignancy across Bethesda Categories

Concordance analysis showed that 93% of cases were concordant between FNAC and histopathology, while 7% were discordant, indicating a high level of agreement. The ROC-based evaluation demonstrated a sensitivity of 68.4% and specificity of 92.6%, reflecting a true positive rate of 0.684 and a low false positive rate of 0.074, supporting good diagnostic performance of FNAC.

Risk of malignancy increased across Bethesda categories, being 7.7% in Category II, 50% in Category III, 10% in Category IV, 66.7% in Category V, and 100% in Category VI. Overall, there was a progressive rise in malignancy risk with higher categories, highlighting the strong predictive value of the Bethesda System.

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DISCUSSION

The present study evaluated the diagnostic accuracy of FNAC using the Bethesda system in comparison with histopathological findings in thyroid nodules. FNAC demonstrated high specificity (96.8%) and good overall accuracy (81%), reinforcing its role as a reliable initial diagnostic modality. The high specificity indicates that FNAC is highly effective in correctly identifying benign lesions, thereby reducing unnecessary surgical interventions.[13]

The distribution of FNAC categories revealed that the majority of cases (65%) were classified as benign, which correlates well with the known epidemiological pattern of thyroid nodules. However, histopathological examination showed a slightly higher percentage of benign lesions (81%), suggesting that some lesions categorized as indeterminate or suspicious on FNAC were ultimately benign. This discrepancy highlighted the limitations of cytological evaluation, especially in follicular-patterned lesions.[14]

The sensitivity of FNAC in this study was 68.4%, which is relatively moderate. This indicates that a proportion of malignant cases were not detected on cytology, reflecting false-negative results. Zhu Y, et. al; 2020, studies where sampling errors and overlapping cytological features contributed to reduced sensitivity. In particular, follicular neoplasms constituted 20% of FNAC cases, representing a major source of diagnostic uncertainty, as cytology cannot differentiate between follicular adenoma and carcinoma without histological evidence of capsular or vascular invasion.[15]

The risk of malignancy was observed to increase with higher Bethesda categories, validating the utility of the Bethesda system in risk stratification. Categories such as “suspicious for malignancy” and “malignant” showed strong correlation with histopathological outcomes. However, the AUS category, although small in number (2%), remains a grey zone, often requiring repeat FNAC or further evaluation.[16,17]

The concordance rate between FNAC and histopathology was high (93%), indicating strong agreement between the two diagnostic methods. The discordance rate of 7% was primarily attributed to follicular-patterned lesions, which are well-known diagnostic pitfalls in cytology. These discrepancies emphasized the importance of histopathological confirmation in indeterminate cases.[18]

Papillary carcinoma was identified as the most common malignant lesion, consistent with global epidemiological trends. Similarly, follicular adenoma was the most frequent benign lesion. Rana C, et. al; 2021, reinforced the typical histological spectrum of thyroid nodules. The positive predictive value (68.4%) suggests that a significant proportion of cytologically malignant cases were confirmed histologically, while the high negative predictive value (92.6%) indicates that benign cytological findings are largely reliable. Gul K, et. al; 2009, supported the role of FNAC as a screening tool, particularly in ruling out malignancy.[19,20]

Despite its advantages, FNAC has inherent limitations, including sampling error, inadequate cellularity, and interpretative variability. Therefore, FNAC findings should always be interpreted in conjunction with clinical and radiological data. In cases with discordant findings or indeterminate categories, surgical excision and histopathological examination remain essential. Eszlinger M, et. al; 2017, highlighted that while FNAC is a highly specific and minimally invasive diagnostic tool, its limitations necessitate cautious interpretation. The Bethesda system enhances its diagnostic utility by providing standardized reporting and risk stratification.[21,22]

CONCLUSION

FNAC using the Bethesda system is an effective, minimally invasive, and reliable diagnostic tool for evaluating thyroid nodules, demonstrating high specificity and good overall accuracy. It plays a crucial role in initial screening and risk stratification, thereby guiding clinical management. However, its moderate sensitivity and limitations in diagnosing follicular lesions necessitate histopathological confirmation in selected cases. Integration of FNAC with clinical and radiological findings improves diagnostic precision. Thus, FNAC remains indispensable but should be complemented by histopathology for definitive diagnosis and optimal patient care.

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