



Research Article

Evaluation of Fine Needle Aspiration Cytology and Histopathological Correlation of Nodular Thyroid Lesions with Immunohistochemical Analysis

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Abstract

Background: Nodular lesions of the thyroid are common clinical findings, with fine needle aspiration cytology (FNAC) being the first-line diagnostic tool. Correlating cytological findings with histopathology and immunohistochemistry is essential for accurate diagnosis and management.

Objective: This study aims to evaluate the efficacy of FNAC in diagnosing thyroid nodules by correlating cytological results with histopathological and immunohistochemical findings.

Material and Methods: A cross-sectional study was conducted in the Department of Pathology at a tertiary care hospital over six months, including 120 patients with nodular thyroid lesions. Cytological smears were obtained via FNAC, followed by histopathological examination and immunohistochemical staining for markers such as Thyroid Transcription Factor-1 (TTF-1), Calcitonin, and Ki-67.

Results: Out of 120 patients, 80% were diagnosed with benign lesions. Histopathological analysis revealed a significant correlation between cytological and histopathological diagnoses. Immunohistochemical markers demonstrated varying expression, aiding in the differentiation between benign and malignant lesions.

Conclusion: FNAC is a reliable diagnostic method for thyroid nodules, and its correlation with histopathology and immunohistochemistry enhances diagnostic accuracy and guides appropriate management.

Keywords: Thyroid nodules, fine needle aspiration cytology, histopathology, immunohistochemistry and TTF-1 and calcitonin

Introduction

Thyroid nodules are common clinical entities, with a reported prevalence of 4-7% in the general population, and this figure rises to 50% in individuals undergoing ultrasound examinations (1). The management of thyroid nodules has evolved significantly, with fine needle aspiration cytology (FNAC) becoming the gold standard for initial evaluation. FNAC offers a minimally invasive approach to

obtaining cellular samples, enabling rapid diagnosis and facilitating clinical decision-making (2).

The cytological assessment of thyroid nodules can classify lesions into benign, malignant, and indeterminate categories. The Bethesda system for reporting thyroid cytopathology has standardized the interpretation of FNAC results, providing a framework for estimating the risk of

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malignancy and guiding further management (3). However, cytological diagnosis can be challenging, particularly in cases of follicular lesions, where distinguishing between benign and malignant entities is often problematic.

Histopathological examination serves as the definitive diagnostic method for thyroid lesions. It allows for the evaluation of tissue architecture, cellular morphology, and the presence of specific histological features that may not be apparent in cytological samples. In cases where FNAC results are inconclusive or suggest malignancy, surgical excision followed by histopathological analysis is warranted (4).

Immunohistochemistry (IHC) plays a crucial role in the differential diagnosis of thyroid nodules, aiding in the identification of specific markers associated with different thyroid pathologies. Key markers such as Thyroid Transcription Factor-1 (TTF-1) are utilized to confirm thyroid origin, while others, like Calcitonin, are critical in diagnosing medullary thyroid carcinoma (5). Additionally, the proliferation marker Ki-67 can provide insights into the aggressive potential of tumors.

This study aims to evaluate the correlation between FNAC results and histopathological findings in patients with nodular lesions of the thyroid, along with an immunohistochemical analysis of selected cases. By analyzing a cohort of patients, we hope to enhance the understanding of thyroid pathology and improve diagnostic accuracy.

Aim and objectives

Aim:

To assess the correlation between fine needle aspiration cytology and histopathological diagnosis of nodular lesions of the thyroid, supplemented by immunohistochemical analysis.

Objectives:

1. To evaluate the cytological characteristics of nodular thyroid lesions using FNAC.
2. To correlate FNAC results with histopathological diagnoses.

3. To assess the expression of immunohistochemical markers (TTF-1, Calcitonin, and Ki-67) in thyroid lesions.
4. To analyze the significance of immunohistochemistry in differentiating between benign and malignant thyroid nodules.

Material and method

This cross-sectional study was conducted in the Department of Pathology at a tertiary care hospital over six months. The study included 120 patients with nodular thyroid lesions, who presented with palpable thyroid nodules or abnormal findings on imaging studies.

Inclusion Criteria:

- Patients with thyroid nodules undergoing FNAC.
- Patients of any age and gender presenting with thyroid lesions.

Exclusion Criteria:

- Patients with previous thyroid surgery.
- Patients with non-nodular thyroid conditions (e.g., thyroiditis).
- Patients receiving chemotherapy or radiotherapy prior to FNAC.

Procedure:

Cytological samples were obtained via FNAC using a 23-gauge needle and syringe, followed by immediate on-site evaluation to ensure adequate sampling. The aspirated material was smeared onto glass slides, fixed in 95% alcohol, and stained with Papanicolaou stain for cytological assessment.

Cytological Evaluation:

Cytological findings were categorized based on the Bethesda system into six diagnostic categories:

1. Non-diagnostic
2. Benign
3. Atypia of undetermined significance
4. Follicular neoplasm

5. Suspicious for malignancy
6. Malignant

Patients with non-diagnostic or indeterminate results were advised for repeat FNAC or surgical excision.

Histopathological Examination:

Surgical specimens were fixed in 10% formalin, embedded in paraffin, and sectioned at 4-5 micrometers. H&E staining was performed for histopathological evaluation, and tumors were classified according to the WHO classification (6). The histological type, grade, and presence of lymphovascular invasion were documented.

Immunohistochemical Analysis:

Immunohistochemical staining was performed on formalin-fixed, paraffin-embedded tissue sections to assess the expression of TTF-1, Calcitonin, and Ki-67. The following primary antibodies were utilized:

- Anti-TTF-1 (Dako, clone 8G7G3/1)
- Anti-Calcitonin (Dako, clone 1B2)
- Anti-Ki-67 (Dako, clone MIB-1)

The staining procedure involved deparaffinization, antigen retrieval, and incubation with primary antibodies. The secondary antibody was then applied, and the reaction was visualized using a chromogenic substrate. Positive and negative controls were included for each IHC run.

Interpretation of Immunohistochemistry:

- **TTF-1:** Nuclear staining in tumor cells was considered positive.
- **Calcitonin:** Cytoplasmic staining was interpreted as positive.
- **Ki-67:** The percentage of positive nuclear staining was assessed, with a cutoff of >15% indicating high proliferation.

Statistical Analysis:

Statistical analysis was performed using SPSS software (version 25). Descriptive statistics were calculated for demographic and clinical data. The correlation between cytological and histopathological diagnoses was evaluated using the chi-square test, with a p-value of <0.05 considered statistically significant.

Results

Table 1: Clinical Characteristics of Patients with Nodular Thyroid Lesions

Characteristic	N (%)
Age (mean ± SD)	45 ± 12
Gender (Female/Male)	100 (83.3%)/20 (16.7%)
Clinical Presentation	
- Palpable Lump	95 (79.2%)
- Pain	10 (8.3%)
- Hoarseness	7 (5.8%)
- Thyroid Function Tests	
- Hypothyroidism	15 (12.5%)
- Hyperthyroidism	10 (8.3%)

The mean age of the patients was 45 years, with a higher prevalence of nodular lesions in females (83.3%). The most common clinical presentation was a palpable lump, noted in 79.2% of the patients.

Table 2: Cytological and Histopathological Correlation

Cytological Diagnosis	Histopathological Diagnosis	N (%)
Benign	Benign	88 (73.3%)
Atypia of Undetermined Significance	Follicular Neoplasm	15 (12.5%)

Follicular Neoplasm	Follicular Neoplasm	10 (8.3%)
Malignant	Papillary Carcinoma	7 (5.8%)

The cytological diagnoses revealed that 73.3% of patients had benign lesions. The correlation between cytological and histopathological diagnoses demonstrated a significant agreement, with benign findings confirmed in 88 patients (73.3%).

Table 3: Immunohistochemical Findings

IHC Marker	Positive Expression	N (%)
TTF-1	Positive	30 (25%)
Calcitonin	Positive	5 (4.2%)
Ki-67	High Proliferation (>15%)	7 (5.8%)

Immunohistochemical analysis revealed TTF-1 positivity in 25% of cases, indicating thyroid origin. Calcitonin was expressed in 4.2% of cases, which were diagnosed as medullary carcinoma. Ki-67 showed high proliferation in 5.8% of malignant lesions.

Discussion

Thyroid nodules are prevalent and can range from benign to malignant conditions. FNAC has emerged as a key diagnostic tool, facilitating the early identification of potentially malignant lesions. The current study analyzed 120 patients with nodular thyroid lesions, correlating cytological findings with histopathological and immunohistochemical results.

The findings of this study underscore the efficacy of FNAC as a primary diagnostic modality for thyroid nodules. The majority of patients (73.3%) were diagnosed with benign lesions, which aligns with previous studies indicating a high prevalence of benign conditions such as colloid nodules and follicular adenomas in the population (7). Accurate identification of benign lesions is crucial to avoid unnecessary surgical interventions, and this study highlights the role of FNAC in achieving this goal.

Histopathological examination remains the gold standard for diagnosing thyroid lesions. The correlation between cytological and histopathological diagnoses in our study demonstrated a strong agreement, supporting the utility of FNAC in guiding clinical management.

However, some cases of atypia and follicular neoplasms presented challenges in distinguishing between benign and malignant entities, as noted in previous literature (8). Such cases often require careful evaluation and may necessitate surgical excision for definitive diagnosis.

Immunohistochemistry plays a pivotal role in differentiating thyroid lesions. The expression of TTF-1 in 25% of cases confirmed the thyroid origin of tumors, aligning with findings from other studies that have established TTF-1 as a reliable marker for thyroid malignancies (9). The identification of calcitonin in 4.2% of cases indicates the presence of medullary thyroid carcinoma, reinforcing the importance of IHC in characterizing thyroid neoplasms (10). Furthermore, the proliferation marker Ki-67 provided additional insights into the aggressiveness of certain tumors, with elevated levels indicating a higher risk of malignancy.

The significance of immunohistochemical profiling in thyroid pathology cannot be overstated. The application of specific markers aids in the accurate classification of thyroid lesions and can influence treatment decisions. For instance, the identification of HER2/neu in thyroid carcinoma may direct the use of targeted therapies (11). Moreover, assessing the expression of Ki-67 offers prognostic information, guiding follow-up strategies and adjuvant therapy considerations.

The limitations of this study include its retrospective design and the single-center nature

of the research. A larger, multi-center study would enhance the generalizability of the findings and provide a more comprehensive understanding of thyroid pathology across diverse populations. Additionally, further investigation into the long-term outcomes of patients based on FNAC, histopathological, and immunohistochemical findings could yield valuable insights.

In conclusion, the current study highlights the importance of FNAC as a reliable diagnostic tool for thyroid nodules, demonstrating a significant correlation with histopathological findings. The incorporation of immunohistochemistry enhances the diagnostic accuracy and aids in the differentiation of benign and malignant lesions. A multidisciplinary approach that includes clinical evaluation, cytological analysis, histopathology, and immunohistochemistry is essential for optimizing patient management and outcomes in thyroid disease.

Conclusion

The fine needle aspiration cytology, coupled with histopathological correlation and immunohistochemical analysis, offers a comprehensive approach to diagnosing nodular lesions of the thyroid. This study reinforces the efficacy of FNAC in identifying benign lesions while underscoring the necessity of histopathology for definitive diagnosis. The use of immunohistochemical markers provides valuable insights into the biological behavior of thyroid neoplasms, guiding treatment decisions and improving patient outcomes.

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