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DIAGNOSTIC ACCURACY OF FINE NEEDLE ASPIRATION CYTOLOGY IN SOLITARY THYROID NODULE

Original Research

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ABSTRACT

Background: Objective: To determine the accuracy of fine needle aspiration cytology (FNAC) in solitary thyroid nodules.

Study Design: The study design selected for this was Cross-sectional observational study.

Place and Duration of Study: Current research was conducted in Jinnah Postgraduate Medical Centre, Karachi (Surgical Unit II) over one year time period year (from April 1, 2023, to March 31, 2024).

Methodology: All patients aged above 12 years of both genders, diagnosed with solitary thyroid nodules on clinical examination and ultrasonography, were included. FNAC was performed in the outpatient department, and cytology reports were categorized as benign or malignant. Patients subsequently underwent hemithyroidectomy, and histopathological findings were compared with FNAC results to determine diagnostic accuracy.

Results: A total of 36 patients were included, comprising 29 females and 7 males, with ages ranging from 13 to 70 years (mean age: 36.69 ± 13.97 years). Among 3 inconclusive FNAC results, 1 was benign and 2 were malignant on histopathology. Of the 20 cases diagnosed as benign by FNAC, 19 were confirmed benign, while 1 was malignant on final histopathology−indicating an accuracy of 95% for benign lesions. FNAC categorized 8 cases as suspicious for malignancy, while histopathology confirmed 15 malignant cases overall.

Conclusion: FNAC is a reliable diagnostic tool for evaluating solitary thyroid nodules and can effectively guide clinical management when performed by experienced professionals.

Keywords: Solitary thyroid nodules, Fine needle aspiration cytology, Thyroid malignancy.

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INTRODUCTION

The thyroid gland, a major endocrine structure, is anatomically composed of two lobes joined by a thin bridge known as the isthmus. The development of thyroid nodules is a common clinical finding, and the majority of these nodules are non-cancerous and do not interfere with hormonal regulation. In China, population studies utilizing ultrasonography have identified nodules greater than 5 mm in nearly one-fifth of adults, with malignancy observed in approximately 8% to 16% of these cases. Papillary thyroid carcinoma (PTC) remains the predominant malignancy among thyroid cancers, while tumors smaller than 10 mm are referred to as papillary thyroid microcarcinomas (PTMCs). Advancements in diagnostic imaging and increased screening during physical examinations have led to a noticeable rise in the detection of small thyroid lesions. Despite many of these cancers following a slow-growing course, timely identification and proper clinical management remain essential for optimizing long-term health outcomes and life quality (1).

When a solitary thyroid nodule is detected, evaluating the potential for malignancy becomes a clinical priority. Fine needle aspiration cytology (FNAC) serves as a frontline diagnostic tool to differentiate between non-cancerous and malignant thyroid lesions. Gender distribution studies have consistently shown a greater frequency of thyroid diseases in women compared to men. Research data has revealed that among patients undergoing evaluation, the majority of nodules (about 90%) are benign, while a smaller fraction (roughly 7%) are malignant, and around 2% fall into a suspicious category. These findings emphasize the need for a structured and reliable diagnostic approach to guide appropriate therapeutic decisions. In regions where thyroid disorders are prevalent, particularly among females, FNAC provides a valuable method for early risk stratification, ensuring that unnecessary surgeries are minimized while ensuring that malignancies are not overlooked. This early triage system plays a critical role in the effective clinical workflow for thyroid nodule management (2).

FNAC is most beneficial when evaluating thyroid nodules that are larger than 1 cm, especially when ultrasound imaging suggests intermediate to high risk of malignancy. Cytological interpretations are standardized through the Bethesda System, which categorizes results into six diagnostic groups. For inconclusive or nondiagnostic outcomes (Bethesda I), a repeat aspiration is typically advised. Cases labeled as Bethesda II, which are benign, are usually monitored using clinical evaluations and follow-up imaging. Categories such as Bethesda III, indicating atypia of undetermined significance, may require further assessment, possibly through repeat aspiration or molecular testing—though such testing may be limited in availability in certain regions. The remaining Bethesda categories—IV, V, and VI—suggest increasing levels of cancer suspicion or confirmation and often necessitate surgical removal. Applying the Bethesda System not only streamlines diagnosis but also helps in guiding clinicians on when to observe, when to repeat tests, and when to proceed with surgical intervention (3).

FNAC was first introduced by Martin and Ellis in 1930. Its adoption has significantly reduced unnecessary thyroidectomies. However, increased use has also led to a higher reported incidence of thyroid cancers post-surgery—from 5–10% to 30–50%. FNAC is critical in deciding management, but accuracy depends on the technique, cytologist expertise, and contextual clinical evaluation【Ref 4】.

FNAC typically uses 22–27-gauge needles (25–27 being most common). While the procedure appears simple, it demands significant skill and experience. Debate continues regarding the ideal qualifications for performing FNAC, but optimal outcomes are seen when both the aspirator and the interpreting pathologist are experienced【Ref 5】.

One study found sensitivity of 64.96%, specificity of 62.7%, positive predictive value of 59.3%, and negative predictive value of 68.2%—highlighting the need to consider clinical and radiological context alongside FNAC【Ref 6】.

Histopathological examination after hemithyroidectomy remains the gold standard for final diagnosis. However, ultrasound-guided FNAC has shown good diagnostic performance, with a sensitivity of 90.7%, specificity of 53.6%, and accuracy of 64.1%【Ref 7】.

Approximately 30% of solitary thyroid nodules are malignant, underscoring the importance of FNAC in excluding cancer【Ref 8】. Nodule size also correlates with malignancy risk: nodules <20 mm tends to be benign, while those 20–40 mm show higher malignancy rates【Ref 9】.

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In many cases, hemithyroidectomy followed by histopathology is necessary to confirm malignancy. If FNAC reveals malignancy, surgery is indicated in all cases. Even benign nodules may require surgery for symptomatic or cosmetic reasons.

The aim of current research is to determine the diagnostic accuracy of FNAC in solitary thyroid nodules. If proven reliable, this could help avoid unwanted surgeries and associated complications including recurrent laryngeal nerve injury and hypocalcemia.

RESULTS

A total of 36 patients were included in the study, comprising 29 females (80.6%) and 7 males (19.4%). The patients' ages ranged from 13 to 70 years, with a mean age of 36.69 ± 13.97 years.

All patients had solitary thyroid nodules and underwent FNAC preoperatively as part of their diagnostic workup. FNAC results were classified according to the Bethesda system as follows:

- three cases of Bethesda I (Inconclusive)
- 20 cases of Bethesda II (Benign)
- four cases of Bethesda III (Atypia of undetermined significance)
- three cases of Bethesda IV (Follicular neoplasm/suspicious for follicular neoplasm)
- six cases of Bethesda V (Suspicious for malignancy)
- and no case of Bethesda VI (Malignant)

For simplification, FNAC results were grouped into three categories:

- Inconclusive: 3
- Benign: 20
- Malignant/Suspicious for Malignancy: 13

All patients underwent hemithyroidectomy, and histopathology reports were subsequently reviewed. The final histopathological diagnoses included:

- Benign nodular hyperplasia: 18 cases
- Papillary carcinoma: 10 cases
- Follicular carcinoma: 2 cases
- Anaplastic carcinoma: 2 cases
- Hurthle cell carcinoma: 1 case
- Adenomatoid change: 1 case
- Noninvasive follicular neoplasm with papillary-like nuclear features: 1 case
- Hashimoto thyroiditis: 1 case

Based on histopathology, the simplified diagnostic breakdown was:

- Benign: 21 cases
- Malignant: 15 cases
- Inconclusive: 0 cases

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Comparing FNAC with histopathology:

- Out of 3 inconclusive FNAC cases, 1 was benign and 2 were malignant on histopathology.
- Of the 20 FNAC-benign cases, 19 were confirmed benign, and 1 was found malignant−giving an FNAC accuracy of 95% for benign disease.
- FNAC identified 8 cases as suspicious for malignancy, while histopathology confirmed 15 malignant cases overall.

Table-1: Evaluation of Fine Needle Aspiration Cytology (FNAC) Diagnostic Performance in Identifying Solitary Thyroid Nodules

	Histopathology			
FNAC	**Benign**	**Malignant**	**Total**	**Accuracy (%)**
Bethesda I (Inconclusive)	1	2	3	0.00%
Bethesda II (Benign)	19	1	20	95.0%
Bethesda III (Probably benign)	4	0	4	100.00%
Bethesda IV (Suspicious of malignancy)	0	3	3	100.00%
Bethesda V (Highly suspicious of malignancy)	1	5	6	83.30%
Total	**25**	**11**	**36**	

DISCUSSION

Thyroid diseases, both benign and malignant, are prevalent in our population. Patients may present with a solitary nodule, multiple nodules, or diffuse glandular swelling. Among these, solitary "cold" nodules on thyroid scans are of particular concern, as they carry a relatively higher risk of malignancy as compared to "hot nodules.

Fine needle aspiration cytology (FNAC) plays a crucial role in evaluating cold nodules and helps guide the subsequent management strategy. According to the American Thyroid Association (ATA), FNAC is recommended for nodules with high or intermediate suspicion measuring ≥1 cm, low suspicion ≥1.5 cm, and very low suspicion ≥2 cm. Similar thresholds are recommended by the Korean Society of Thyroid Radiology. The American College of Radiology (ACR) also advises FNAC for highly suspicious nodules ≥1 cm and sets higher thresholds for nodules with lower suspicion【Ref 10】.

The majority of patients were female (29 out of 36; 80.5%) In the current study, consistent with findings from I.M. Abdullahi et al., where 84% of patients were female【Ref 11】. This supports the widely accepted observation that thyroid disorders are more common

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among women. The mean age in our study was 41.5 years, closely aligning with the findings of Manoj VV et al., who reported a mean age of 45.51 years【Ref 12】—suggesting that thyroid disease primarily affects middle-aged individuals.

Laterality analysis showed right lobe involvement in 63.89% of cases (23 patients), while 36.11% (13 patients) had left lobe involvement. Haider et al. similarly observed right lobe involvement in 56% of patients【Ref 13】. This may be attributed to anatomical and functional asymmetries between the lobes.

In our study, malignancy was confirmed in 15 out of 36 patients (41.66%). Among these, 9 were female (25%) and 6 were male (16.66%). In contrast, a study by J.-M. Prades et al. found malignancy in 22% of females and 25% of males【Ref 14】. The higher rate of malignancy among females in our study may reflect the relatively small number of male patients.

Our reported malignancy rate of 41.66% is notably higher than the 20% reported by Palani V et al.【Ref 15】. This difference may be due to variations in sample size, study setting, or population characteristics.

In this study, FNAC showed a diagnostic accuracy of 95% for benign disease. This is consistent with findings from another study where FNAC sensitivity was 91.66%, specificity 98.15%, and overall accuracy 94.06%【Ref 16】. However, in our data, FNAC had a specificity of 25%, sensitivity of 75%, negative predictive value of 47.05%, and a positive predictive value of 52.29%. In contrast, another study reported much higher values: 93.9% sensitivity, 100% specificity, and a 100% positive predictive value【Ref 17】.

Malignancy was correctly identified by FNAC in 83.3% of cases in our study, similar to findings from another study that reported 81.25% sensitivity and 98.84% specificity【Ref 18】.

Although sensitivity and specificity values for FNAC vary across different studies, it continues to serve as a crucial and a minimally invasive technique for evaluating thyroid nodules. The diagnostic reliability of FNAC is strongly influenced by the skill and expertise of both the clinician performing the aspiration and the cytopathologist interpreting the results.

Despite the clinical relevance of our findings, several limitations must be acknowledged. The relatively small sample size restricts the strength and applicability of our conclusions across broader populations. Additionally, none of the enrolled patients were diagnosed with Bethesda VI (malignant) nodules, limiting the evaluation of FNAC's performance in this high-risk category. Another constraint was the unavailability of advanced molecular diagnostic tools such as ThyGenext® and ThyroSeq V3®, which are widely used internationally to further assess Bethesda III lesions (atypia or follicular lesions of undetermined significance). This lack of access impairs our ability to refine diagnostic accuracy in indeterminate cases. To address these challenges and validate FNAC's role more comprehensively, we recommend future multicenter studies with larger cohorts and inclusion of molecular testing methodologies where feasible.

CONCLUSION

Fine Needle Aspiration Cytology (FNAC) remains an essential diagnostic modality in the initial assessment and management of thyroid nodules. Its minimally invasive nature, combined with cost-efficiency and high diagnostic accuracy, makes it a preferred choice for differentiating benign from malignant thyroid lesions. When conducted by skilled clinicians and interpreted by experienced cytopathologists, FNAC can significantly minimize the need for avoidable surgical procedures. The findings of this study affirm the clinical value of FNAC in evaluating solitary thyroid nodules. However, it is important to recognize that the technique's diagnostic precision can vary depending on the proficiency of the operator and the quality of cytological assessment. Overall, FNAC plays a vital role in guiding treatment decisions and optimizing patient care pathways in thyroid nodule evaluation.

AUTHOR CONTRIBUTION

Author	Contribution
Resham Ali*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tunza Irfan	Substantial Contribution to study design, acquisition and interpretation of Data

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	Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Syed Shafqatullah	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Mazhar Iqbal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Amna Fareed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Kainat Zafar	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Sitara Kotak	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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