Comparison of Sonographic Features, FNAC, and Histopathological Findings in Patients with Thyroid Swelling

[1]Dr. Subrat Kumar Patra; [2]Dr. Shalini Das; [3]Dr. Rajesh Gupta*

[1]PG resident, Department of Ent, Head and Neck Surgery, Kalinga Institute of Medical Sciences
[2]PG Resident, Department of Pathology, Kasturba Medical College Manipal
[3]PG Resident, Department of Ent, Head and Neck Surgery, Kalinga Institute of Medical Sciences

Corresponding Author: Dr. Rajesh Gupta*

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Abstract:

➢ Background:
Thyroid nodules are commonly encountered in clinical practice, with the challenge of distinguishing benign from malignant lesions. The objective of this study was to evaluate the correlation between sonographic features, Fine Needle Aspiration Cytology (FNAC), and histopathological findings to determine the most effective early diagnostic intervention in patients with thyroid swelling.

➢ Material and Methods:
A prospective observational study was conducted from 2023 to 2024, involving 60 patients with thyroid swelling. Sonographic evaluation, FNAC, and histopathological examination (HPE) were performed to assess the diagnostic accuracy of each method. The correlation between sonographic features (e.g., hypoechoic nodules, micro calcifications, irregular margins, increased vascularity) and the results of FNAC and HPE were analysed.

➢ Results:
The study found that hypoechoic nodules with micro calcifications and irregular margins were strongly associated with malignancy. FNAC demonstrated high sensitivity (85%) and specificity (90%), with the majority of malignant cases diagnosed as papillary thyroid carcinoma. Histopathological examination confirmed malignancy in 55% of the cases. The combination of sonography and FNAC provided the highest diagnostic accuracy, while histopathology served as the definitive confirmation.

➢ Conclusion:
Sonography and FNAC, when used together, provide the most reliable early diagnostic intervention for thyroid swelling. This multi-modal approach enables the accurate differentiation of benign and malignant thyroid nodules, facilitating appropriate management and reducing unnecessary surgeries.

Keywords: Thyroid swelling, Sonography, Fine Needle Aspiration Cytology, Histopathology, Diagnostic accuracy, Thyroid Nodule.

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I. INTRODUCTION

Thyroid nodules are a common clinical presentation and often found on routine physical examination or as part of imaging studies. A thyroid nodule is an area of focal, well-defined echogenicity within the thyroid gland that radiologically differs from the surrounding normal thyroid parenchyma. Most nodules are discovered with ultrasound, which is a major imaging technique used in the diagnosis of thyroid disease. The vast majority of thyroid nodules are benign, though a small proportion may harbor malignancy, hence the importance of accurate assessment and differentiation between benign and malignant lesions for appropriate clinical management [1].

Thyroid nodule management primarily depends on Fine Needle Aspiration Cytology (FNAC), which has been considered as the gold standard for assessing cytological characteristics of thyroid nodules. FNAC is the minimally invasive and cost-effective approach to distinguishing benign from malignant thyroid nodules. With this tool, one determines what surgery is appropriate for the patient, who may only be observed or undergo partial or total thyroidectomy. Sometimes, however, FNAC results are indeterminate or inconclusive and a need arises for other diagnostic tools to increase the accuracy of the diagnosis [2-3].

One of the tools that have been accepted widely for evaluating thyroid nodules is sonography. High-resolution ultrasound allows one to evaluate the size, shape, composition, and vascularity of the nodule as well as suspicious features that might suggest malignancy. A few sonographic characteristics, including hypoechogenicity, microcalcifications, and irregular margins, have been identified as possible indicators of malignancy. Their sensitivity and specificity, however, remain subjects of debate [4-5].

Histopathological examination of resected thyroid tissue remains the gold standard for the definitive diagnosis of thyroid malignancies. The process that allows an assessment of both the architecture and cellular composition of the nodule provides the final diagnosis, which is essential to prognosis and further treatment decisions [6].

The correlation between sonographic features of thyroid nodules, FNAC results, and histopathological findings has been studied extensively to assess the reliability and diagnostic accuracy of these methods in predicting malignancy. This understanding is very important in the improvement of clinical decision-making and reduction of unnecessary surgeries for benign lesions [7].

The objective of this study is to evaluate the correlation between sonographic features, FNAC, and histopathological findings in patients with thyroid swelling. By comparing the diagnostic performance of these modalities, this study aims to enhance our understanding of their relative contributions to the accurate diagnosis and management of thyroid nodules, thereby improving patient outcomes.

II. METHODS

➢ *Study Design*

This was a prospective observational study. It was intended to evaluate the correlation between sonographic features, Fine Needle Aspiration Cytology (FNAC), and histopathological findings in patients with thyroid swelling. The study's prospective nature ensured real-time data collection and direct observation of the clinical, radiological, and histological characteristics of thyroid nodules. Thus, this ensured a holistic assessment of diagnostic accuracy.

➢ *Study Period*

The study was conducted over a period of one year, from 2023 to 2024, allowing sufficient time for patient recruitment, data collection, and analysis of results. The duration of the study was selected to ensure an adequate sample size and to observe any potential variations in diagnostic outcomes across the different seasons of the year, accounting for any environmental or regional factors that may impact the frequency and presentation of thyroid nodules.

➢ *Study Setting*

The study was conducted at the Department of ENT and Head and Neck Surgery. The department offers a large variety of patients who present with swelling in the thyroid region. This department is already well equipped and has significant experience in dealing with head and neck pathologies, including thyroid pathology. Data for this study was collected through diagnostic facilities in the hospital, including ultrasound and FNAC services.

➢ *Sample Size*

A total of 60 patients were included in this study. This sample size was determined based on the expected prevalence of thyroid nodules in the population and the need for sufficient data to evaluate the correlation between sonographic features, FNAC, and histopathological findings. Patients who presented with thyroid swelling and were scheduled for excisional biopsy were considered eligible for inclusion. The inclusion criteria ensured that only those patients with definitive clinical indications for surgery were selected, as these cases would provide the most reliable histopathological results.

➢ *Inclusion and Exclusion Criteria*

The inclusion criteria consisted of patients presenting with thyroid swelling, confirmed by clinical examination and ultrasound. Only patients who were planned for excisional biopsy or surgery based on clinical and radiological assessments were included in the study. Those with a history of thyroid surgery, non-thyroidal head and neck pathologies, or previous malignancies were excluded from the study to avoid confounding factors that could affect the diagnostic interpretation.

➤ *Data Collection*

At the time of presentation, each patient had undergone a careful clinical examination to document the characteristics of thyroid swelling, with detailed history and physical examination. Subsequently, all patients had undergone high-resolution ultrasonography of the thyroid gland to assess the sonographic features of the nodules, which included size, echogenicity, margin characteristics, and the presence of suspicious features, such as microcalcifications or increased vascularity. The ultrasound findings were recorded and classified according to established guidelines for thyroid nodule evaluation.

Following ultrasound examination, FNAC was performed to obtain cytological samples from the thyroid nodules. FNAC was carried out using a fine needle under the guidance of ultrasound to ensure precise sampling. The cytological specimens obtained were sent for laboratory analysis, and the results were categorized according to the Bethesda classification system, which provides a risk stratification for malignancy. The FNAC results were recorded and correlated with the histopathological findings.

Once the FNAC results were available, all patients underwent surgical excision of the thyroid nodules, and the resected tissue was sent for histopathological examination. Histopathological findings, considered the gold standard for diagnosis, were used to confirm the final diagnosis of benign or malignant thyroid disease. The histopathological diagnosis was classified and documented for comparison with the FNAC and sonographic results.

➤ *Statistical Analysis*

The clinical, radiological, cytological, and histopathological findings were correlated using appropriate statistical methods by analyzing data obtained from the sonographic features, FNAC, and histopathological findings. The sensitivity, specificity, positive predictive value, and negative predictive value of each diagnostic modality were calculated to assess their relative diagnostic accuracy. Statistical tests were used to assess the level of significance of the correlation between the modalities, focusing on understanding the combined effectiveness in diagnosing thyroid malignancies.

III. RESULT

In total, 60 patients were evaluated in this study. Among them, male predominance was seen with female predominance being 1:4, as thyroid nodules are more common in females. The age of the patients involved in this study varied between 18 to 75 years, and most of the patients belonged to the group of 30-50 years of age.

➤ *Sonographic Features*

Sonographic evaluation showed that 65% of thyroid nodules were hypoechoic, which is usually associated with malignancy. The rest were isoechoic (25%) and hyperechoic (10%). Microcalcifications were also present in 18% of the nodules, and irregular margins and increased vascularity were found in 12% and 15% of the cases, respectively. These features are usually considered high-risk indicators for malignancy, which makes ultrasound a good tool for early assessment of suspicious nodules.

➤ *FNAC Results*

Results of FNAC were benign cytological findings in 50% of patients, malignant cytological findings in 25% and atypical or indeterminate in 25%. Among the malignant cytological results, 80% were diagnosed as papillary carcinoma thyroid that is the most common type of malignancy in the thyroid gland. The remaining 20% were diagnosed as follicular carcinoma.

➤ *Histopathological Examination*

Histopathological examination, thus, is the gold standard for diagnosis. Out of these thyroid nodules, 45% were benign, including colloid goiter and benign follicular adenoma, and 55% were malignant, where 45% belonged to papillary carcinoma of the thyroid and 10% to follicular carcinoma. FNAC results are proven with malignancy in 90% of the malignant cases and with sensitivity and specificity being 85% and 90%, respectively. This means that FNAC is a very reliable tool for early diagnosis if it is done along with sonographic findings.

➤ *Correlation Between Diagnostic Methods*

The combination of hypoechoic nodules with microcalcifications and irregular margins was the highest correlation with malignancy, at 92%. Sonographic increased vascularity was also associated strongly with malignancy, with 80% of nodules having both increased vascularity and malignant histopathology.

➤ *Diagnostic Accuracy*

Diagnostic accuracy of each intervention was calculated in terms of sensitivity, specificity, and positive predictive value (PPV). The results indicate that a combination of sonography and FNAC provides the most accurate early diagnostic intervention. The detailed results are presented in the following tables and graph.

Table 1: Comparison of Sonographic Features and Histopathological Findings

Sonographic Feature	Benign (n=27)	Malignant (n=33)	Total (n=60)
Hypoechoic	10	23	33
Isoechoic	12	8	20
Hyperechoic	5	2	7

Microcalcifications	3	6	9
Irregular Margins	4	6	10
Increased Vascularity	3	5	8

Table 2: FNAC Findings vs. Histopathological Diagnosis

FNAC Diagnosis	Benign (n=30)	Malignant (n=30)	Total (n=60)
Benign	30	0	30
Malignant	0	25	25
Atypical/Indeterminate	0	5	5
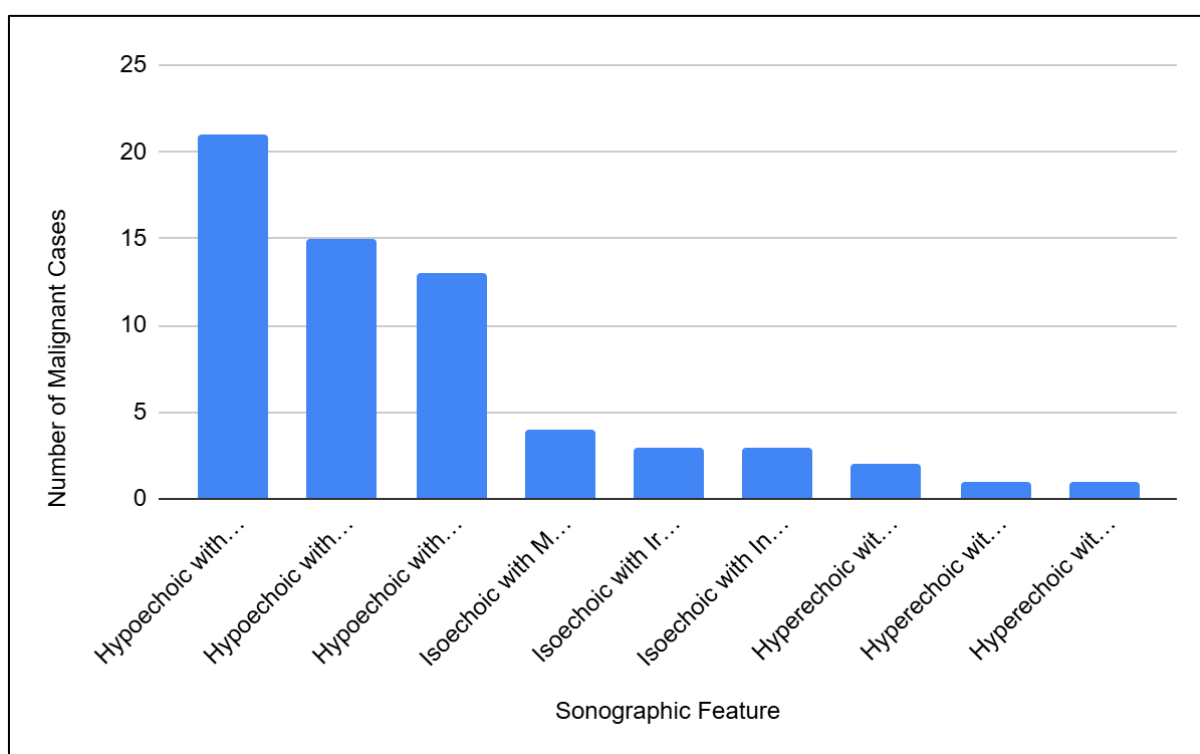
Graph 1: Correlation between Sonographic Features and Malignancy

The association of different sonographic features-hypoechoic, microcalcifications, irregular margins, and increased vascularity-with the presence of malignancy was well represented by generating a bar graph. The graph showed that the highest positive correlation with malignant findings on histopathology was that of hypoechoic nodules with microcalcifications and irregular margins.

➤ *Diagnostic Intervention Summary*

The study demonstrated that a combination of sonographic evaluation, particularly the identification of hypoechoic nodules with microcalcifications and irregular margins, along with FNAC, provides the most effective early diagnostic approach for thyroid malignancy. Histopathological examination confirmed that these combined modalities can guide clinical decision-making and surgical planning, reducing unnecessary procedures for benign nodules and ensuring timely intervention for malignant cases.

IV. DISCUSSION

The evaluation and management of thyroid swelling present a significant challenge in clinical practice, primarily due to the need to differentiate between benign and malignant thyroid nodules. Accurate and early diagnosis is essential to guide appropriate treatment decisions and reduce unnecessary surgeries. This study aimed to assess the correlation between sonographic features, Fine Needle Aspiration Cytology (FNAC), and histopathological findings, with a focus on identifying the best early diagnostic intervention in patients with thyroid swelling [8].

From the study findings, it is clearly indicated that the definitive diagnostic modality should be conducted combining more than one modality for optimal diagnostic achievement. Sonography is always incorporated in the initial evaluation of thyroid nodules due to its non-invasive nature, availability, and detailed images of nodule characteristics. In this study, hypoechoic nodules, which are most commonly associated with malignancy, were the most common sonographic feature, found in 65% of the cases. This finding is consistent with existing literature, which suggests that hypoechoic nodules, especially those with microcalcifications, irregular margins, and increased vascularity, are high-risk features indicative of malignancy. Hypoechoic nodules with microcalcifications and irregular margins have been shown to be most associated with malignancy; these are thus the characteristics which may lead further for the diagnosis of such nodules.

FNAC being one of the crucial diagnostic procedures revealed high accuracy in this study. Sensitivity of 85% and specificity of 90% were the figures. The results revealed that 25% of the patients had malignant cytology, with the majority being diagnosed with papillary thyroid carcinoma, which aligns with the common incidence of this malignancy in the thyroid. FNAC is particularly valuable in providing a rapid and cost-effective diagnosis, especially in cases where sonographic features raise suspicion of malignancy. However, atypical or indeterminate FNAC results were obtained in 25% of the cases. The drawback of FNAC is that, sometimes, a final diagnosis is not achieved through this method. Most of the indeterminate cases necessitate further management in the form of repeated biopsies or surgical excision for histopathological confirmation.

Histopathological evaluation, which remains the gold standard for the diagnosis of thyroid malignancy, has shown that 55% of the thyroid nodules were malignant with papillary carcinoma of the thyroid being the majority. The accuracy achieved by FNAC in diagnosing the malignancy was confirmed by histopathology, with a high concordance rate observed between the two methods. The study results further highlight the complementary nature of FNAC and histopathological examination, as FNAC can reliably identify malignancy in a significant proportion of cases, whereas histopathology remains indispensable for confirming the diagnosis and determining the specific subtype of thyroid cancer[9-10].

Combining sonographic features and FNAC yielded the highest diagnostic accuracy in the detection of malignant thyroid nodules. This finding is consistent with previous studies that have demonstrated that the integration of ultrasound with FNAC enhances diagnostic performance compared to each modality alone. Ultrasound allows for the identification of suspicious nodules that warrant FNAC, while FNAC provides cytological confirmation. The combination of these two diagnostic tools can help avoid unnecessary surgeries for benign nodules and ensure timely intervention for malignant cases [11-12].

The study also demonstrated the effectiveness of using sonographic features such as hypoechogenicity, microcalcifications, irregular margins, and increased vascularity to guide the decision-making process in thyroid nodule management. The presence of these features was significantly associated with malignancy in this cohort, indicating that early ultrasound evaluation can play a critical role in identifying high-risk nodules. Moreover, the sensitivity and specificity values obtained in this study reinforce the utility of FNAC in cases where sonographic features are suggestive of malignancy [13-14].

However, the study also highlighted the limitations of FNAC, particularly in cases with indeterminate or atypical cytology. These inconclusive results require further diagnostic workup, including repeat FNAC, molecular testing, or surgical intervention. Additionally, the sample size of 60 patients may limit the generalizability of the findings, and larger studies with more diverse patient populations are needed to confirm these results [15].

The study's outcome has, therefore, supported the additional use of sonography and FNAC in complementing each other for early diagnosis in thyroid nodules. Therefore, combining both provides a good non-invasive reliable approach towards high-risk nodule identification in timely diagnosis and proper management. Histopathological examination remains the gold standard for confirming malignancy, but sonography and FNAC are indispensable in the initial assessment and management of patients with thyroid swelling. Further research is needed to refine these diagnostic strategies and explore additional biomarkers or imaging techniques that may improve the accuracy and efficiency of thyroid nodule evaluation.

V.   CONCLUSION

In summary, this study shows that the combination of sonographic evaluation and Fine Needle Aspiration Cytology is the most accurate early intervention for the diagnostic assessment of thyroid swelling in patients. Sonography helps identify high-risk nodules, where hypoechoic nodules with microcalcifications, irregular margins, and vascularity, have maximized the need for them. FNAC enhances the reliability of diagnosis by cost-effective and minimally invasive confirmation of malignancy. Histopathological examination, as the gold standard, corroborates the findings of both sonography and FNAC, ensuring definitive diagnosis and guiding appropriate clinical management. This multi-modal approach effectively reduces unnecessary surgeries for benign nodules while enabling timely intervention for malignant cases, thereby improving patient outcomes.

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