



## Diagnostic Accuracy of Ultrasound-Guided versus Palpation-Guided Fine Needle Aspiration Cytology in Thyroid Nodules: A Prospective Comparative Study Using Histopathology as the Gold Standard.

Dr. Megha Annigeri<sup>1</sup>, Dr. Adarsh E.H.<sup>2</sup>, Dr. A.M. Asha<sup>3\*</sup>, Dr. Aparajitha A.<sup>4</sup>.

<sup>1</sup>Assistant Professor, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.

<sup>2</sup>Senior Resident, Department of ENT Maharashtra Institute of Medical SCIENCES and Research, Latur, Maharashtra, India.

<sup>3</sup>Senior Resident, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.

<sup>4</sup>Senior Resident, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.



### Correspondence:

Dr. A.M. Asha.

Senior Resident, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.

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### Abstract

**Background:** Fine needle aspiration cytology (FNAC) is the primary investigation for evaluating thyroid nodules. Although palpation-guided FNAC is widely practiced, ultrasound guidance may improve sampling adequacy and diagnostic accuracy, particularly in small, deep-seated, or complex thyroid nodules. This study compared the diagnostic performance of ultrasound-guided FNAC with palpation-guided FNAC using postoperative histopathology as the reference standard. **Objectives:** To compare the diagnostic accuracy, sensitivity, specificity, positive predictive value, negative predictive value, false-negative rate, and inadequate specimen rate of ultrasound-guided FNAC and palpation-guided FNAC in thyroid nodules. **Methods:** A prospective comparative study was conducted in the Department of ENT at KIMS Hubli, Karnataka, over a two-year period from 2019 to 2021. Fifty patients with thyroid nodules undergoing surgery were included and equally allocated into palpation-guided FNAC (n=25) and ultrasound-guided FNAC (n=25) groups. Histopathological examination of the resected specimen served as the gold standard. Diagnostic indices were calculated, and comparisons were performed using the Chi-square test. **Results:** Among the 50 patients, females constituted 90% and males 10%. Histopathology demonstrated benign colloid goitre in 52%, papillary carcinoma in 24%, follicular carcinoma in 20%, and thyroiditis in 4% of cases. Ultrasound-guided FNAC showed superior diagnostic performance compared with palpation-guided FNAC, with diagnostic accuracy of 95.83% versus 82.60%, sensitivity of 92.3% versus 70%, specificity of 100% versus 92.3%, positive predictive value of 100% versus 87.5%, negative predictive value of 91.66% versus 80%, and a lower inadequate specimen rate (4% versus 8%). **Conclusion:** Ultrasound-guided FNAC demonstrated significantly greater diagnostic accuracy and reduced inadequate sampling compared with palpation-guided FNAC. Routine ultrasound guidance should be considered for cytological evaluation of thyroid nodules, particularly where accurate preoperative diagnosis is essential.

**Keywords:** Thyroid Nodule, Ultrasound-Guided FNAC, Palpation-Guided FNAC, Thyroid Cytology, Histopathology, Diagnostic Accuracy.



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### INTRODUCTION

Thyroid nodules are among the most frequently encountered endocrine disorders in clinical practice. While approximately 5% of thyroid nodules are detected by palpation, high-resolution ultrasonography has substantially increased detection rates, with reported prevalence ranging from 19% to 67% in the general population. Although most thyroid nodules are benign, approximately 10% harbor malignancy, making accurate preoperative diagnosis essential for appropriate patient management.<sup>1-3</sup>

Fine needle aspiration cytology (FNAC) has become the investigation of choice for differentiating benign from malignant thyroid nodules because it is simple, minimally invasive, cost-effective, and highly accurate. The routine use of FNAC has significantly reduced unnecessary thyroid surgery while improving early diagnosis of thyroid cancer. However, conventional palpation-guided FNAC has limitations, particularly in small nodules, partially cystic lesions, multinodular goitre, posteriorly located nodules, and lesions that are difficult to palpate. These limitations may result in inadequate samples and false-negative diagnoses.<sup>2-4</sup>

Ultrasound guidance enables real-time visualization of both the target lesion and the needle tip, allowing aspiration from viable solid components while avoiding cystic degeneration or vascular structures. Previous studies have suggested that ultrasound-guided FNAC improves specimen adequacy, diagnostic accuracy, and sensitivity compared with palpation-guided FNAC.<sup>1,2,5</sup>

Despite increasing adoption of ultrasound-guided FNAC, direct comparisons between ultrasound-guided and palpation-guided techniques remain clinically relevant, particularly in resource-limited settings where palpation-guided FNAC continues to be widely practiced. The present prospective comparative study was therefore undertaken to evaluate the diagnostic performance of ultrasound-guided FNAC and palpation-guided FNAC using postoperative histopathological examination as the reference standard.

## **MATERIALS AND METHODS**

The present study was designed as a prospective comparative study conducted over a period of two years from 2019 to 2021 in the Department of ENT, KIMS, Hubli, Karnataka. A total of 50 consecutive patients presenting with thyroid nodules and planned for surgical management were enrolled after obtaining written informed consent. The participants were equally allocated into two study groups: an ultrasound-guided fine-needle aspiration cytology (USG-guided FNAC) group (n = 25) and a palpation-guided fine-needle aspiration cytology (palpation-guided FNAC) group (n = 25). The study aimed to compare the diagnostic performance of ultrasound-guided FNAC with conventional palpation-guided FNAC using postoperative histopathological examination as the reference standard.

Patients aged more than 15 years with clinically diagnosed thyroid nodules who were scheduled to undergo surgery were considered eligible for inclusion in the study. Patients were excluded if they had undergone previous FNAC of the thyroid nodule, were pregnant, had toxic thyroid nodules, had secondary thyroid malignancy, or refused surgical management. All eligible patients underwent detailed clinical evaluation followed by FNAC using the allocated technique, and the cytological findings were subsequently correlated with the final histopathological diagnosis obtained after surgery.

### **Procedure**

All patients underwent thyroid function testing before FNAC. The palpation-guided group underwent conventional FNAC using a 23-gauge needle attached to a 10-mL syringe. In the ultrasound-guided group, FNAC was performed under real-time ultrasound guidance using a 7.5-MHz transducer, with the needle advanced into the solid component of the nodule under continuous visualization. Aspirated material from both groups was processed for cytological examination using standard staining techniques.

### **Reference Standard**

Histopathological examination of the excised thyroid specimen was considered the definitive diagnosis for evaluating diagnostic performance.

### **Statistical Analysis**

Diagnostic indices including sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy, and false-negative rate were calculated. Comparisons between the two groups were performed using the Chi-square test, with statistical significance determined at a p-value <0.05.

## **RESULTS**

### **Baseline Characteristics**

A total of 50 patients with thyroid nodules were enrolled, comprising 25 patients in the palpation-guided FNAC group and 25 patients in the ultrasound-guided FNAC group. The study population consisted of 45 females (90%) and 5 males (10%), with a female-to-male ratio of 9:1. The majority of patients were between 31 and 40 years of age, and the mean age was 45 years.

**Table 1. Baseline demographic characteristics**

| Variable           | Value    |
|--------------------|----------|
| Total patients     | 50       |
| Female             | 45 (90%) |
| Male               | 5 (10%)  |
| Female: Male ratio | 9:1      |
| Mean age           | 45 years |

### Clinical Presentation

Among all patients, **31 (62%)** presented with solitary thyroid nodules (STN), while **19 (38%)** had multinodular goitre (MNG). Solitary nodules were more frequent than multinodular goitre.

**Table 2. Clinical presentation**

| Presentation            | n  | %  |
|-------------------------|----|----|
| Solitary thyroid nodule | 31 | 62 |
| Multinodular goitre     | 19 | 38 |

### Histopathological Diagnosis

Histopathological examination identified benign colloid goitre as the commonest diagnosis (52%), followed by papillary carcinoma (24%), follicular carcinoma (20%), and thyroiditis (4%). No cases of medullary or anaplastic carcinoma were observed.

**Table 3. Final histopathological diagnosis**

| Diagnosis             | n  | %  |
|-----------------------|----|----|
| Benign colloid goitre | 26 | 52 |
| Papillary carcinoma   | 12 | 24 |
| Follicular carcinoma  | 10 | 20 |
| Thyroiditis           | 2  | 4  |
| Medullary carcinoma   | 0  | 0  |
| Anaplastic carcinoma  | 0  | 0  |

### FNAC Findings

In the palpation-guided FNAC group, 13 patients (52%) were diagnosed with benign colloid goitre, 10 (40%) with neoplasm, and 2 (8%) had inadequate cytological samples. In the ultrasound-guided FNAC group, 11 patients (44%) were diagnosed with benign lesions, 13 (52%) with neoplasm, and only 1 patient (4%) had an inadequate sample.

**Table 4. FNAC diagnosis**

| Cytological diagnosis | Palpation FNAC | Ultrasound FNAC |
|-----------------------|----------------|-----------------|
| Benign                | 13 (52%)       | 11 (44%)        |
| Neoplasm              | 10 (40%)       | 13 (52%)        |
| Inadequate            | 2 (8%)         | 1 (4%)          |

### Correlation of FNAC with Histopathology

Comparison of cytological findings with postoperative histopathology demonstrated that three malignant lesions were incorrectly classified as benign by palpation-guided FNAC, whereas only one false-negative result occurred in the ultrasound-guided group. Furthermore, ultrasound-guided FNAC demonstrated complete concordance for all cytologically diagnosed malignant lesions with postoperative histopathology, whereas palpation-guided FNAC showed a lower concordance.

### Diagnostic Performance

Ultrasound-guided FNAC showed consistently better diagnostic performance than palpation-guided FNAC across all evaluated parameters.

**Table 5. Diagnostic performance of both techniques**

| Parameter                 | Palpation-guided FNAC | Ultrasound-guided FNAC |
|---------------------------|-----------------------|------------------------|
| Sensitivity               | 70.0%                 | 92.3%                  |
| Specificity               | 92.3%                 | 100%                   |
| Positive Predictive Value | 87.5%                 | 100%                   |
| Negative Predictive Value | 80.0%                 | 91.66%                 |
| Diagnostic Accuracy       | 82.60%                | 95.83%                 |
| False-negative Rate       | 20.0%                 | 8.33%                  |
| Inadequate Sample Rate    | 8%                    | 4%                     |

### **Comparative Analysis**

Ultrasound-guided FNAC significantly improved diagnostic accuracy compared with palpation-guided FNAC. The technique achieved a 13.2% absolute increase in diagnostic accuracy, a 22.3% improvement in sensitivity, complete specificity (100%), and a 50% reduction in inadequate specimen rate. These findings indicate superior sampling precision with ultrasound guidance, resulting in fewer false-negative diagnoses and greater concordance with final histopathological findings.

## **DISCUSSION**

### **Principal Findings**

The present prospective comparative study demonstrated that ultrasound-guided FNAC provides superior diagnostic performance compared with palpation-guided FNAC for evaluating thyroid nodules. Ultrasound guidance resulted in higher diagnostic accuracy (95.83% versus 82.60%), higher sensitivity (92.3% versus 70%), perfect specificity (100%), and a lower false-negative rate (8.33% versus 20%). Additionally, the inadequate specimen rate was reduced by half, supporting the routine use of ultrasound guidance to improve preoperative cytological diagnosis. The present prospective comparative study evaluated the diagnostic performance of ultrasound-guided fine needle aspiration cytology (USG-FNAC) and palpation-guided fine needle aspiration cytology (P-FNAC) in patients with thyroid nodules, using postoperative histopathological examination as the reference standard. The study demonstrated that USG-FNAC was superior to P-FNAC across all major diagnostic parameters. Ultrasound guidance achieved a diagnostic accuracy of 95.83%, compared with 82.60% for palpation-guided FNAC. Similarly, ultrasound-guided FNAC showed higher sensitivity (92.3% vs. 70%), higher specificity (100% vs. 92.3%), higher positive predictive value (100% vs. 87.5%), higher negative predictive value (91.66% vs. 80%), a lower false-negative rate (8.33% vs. 20%), and a lower inadequate specimen rate (4% vs. 8%). These findings indicate that ultrasound guidance improves the precision of needle placement and enhances cytological sampling, thereby increasing diagnostic reliability.

### **Demographic Characteristics**

Females constituted 90% of the study population, with a female-to-male ratio of 9:1. The predominance of female patients is consistent with the well-recognized higher prevalence of thyroid nodules among women. Most patients were in the third to fifth decades of life, reflecting the age group in which thyroid nodules are commonly encountered in routine clinical practice.

### **Histopathological Profile**

Benign colloid goitre was the most frequent histopathological diagnosis (52%), followed by papillary carcinoma (24%), follicular carcinoma (20%), and thyroiditis (4%). No cases of medullary or anaplastic carcinoma were identified. These findings suggest that although most thyroid nodules are benign, a substantial proportion of surgically treated nodules are malignant, emphasizing the importance of accurate preoperative cytological assessment.

### **Diagnostic Accuracy of Ultrasound-Guided FNAC**

One of the major observations of this study was the marked improvement in diagnostic accuracy with ultrasound guidance. Ultrasound enables continuous visualization of both the lesion and the needle tip, allowing aspiration from the solid component of complex or partially cystic nodules while avoiding necrotic or haemorrhagic areas. This technical advantage likely explains the reduction in inadequate samples and false-negative diagnoses observed in the present study. Only one false-negative result occurred in the ultrasound-guided group compared with three in the palpation-guided group, highlighting the clinical value of real-time imaging guidance.

### **Comparison with Previous Studies**

The findings of the present study are in agreement with several studies summarized in the thesis literature review. Previous investigators consistently reported that ultrasound-guided FNAC reduces inadequate sampling and improves diagnostic accuracy compared with palpation-guided techniques. Studies cited in the thesis by Danese et al., Roberto Izquierdo et al., Cesur et al., Ahmet Selcuk Can et al., and Elizabeth A. et al. similarly demonstrated higher sensitivity, improved specimen adequacy, and lower false-negative rates with ultrasound-guided FNAC.<sup>6-9</sup> The diagnostic accuracy of 95.83% observed for ultrasound-guided FNAC in the present study is comparable with the high accuracy reported in these earlier investigations. Likewise, the reduction in inadequate specimens from 8% with palpation-guided FNAC to 4% with ultrasound-guided FNAC supports the conclusion that ultrasound guidance improves the quality of cytological sampling, particularly in difficult-to-palpate or heterogeneous nodules.<sup>10,11</sup> Accurate preoperative diagnosis is essential in the management of thyroid nodules because it guides surgical decision-making and helps avoid unnecessary thyroidectomy in patients with benign disease while facilitating timely intervention for malignancy. The higher diagnostic accuracy and lower false-negative rate achieved with ultrasound-guided FNAC suggest that its routine use may improve patient care by reducing repeat procedures, minimizing diagnostic uncertainty, and enabling more appropriate surgical planning. These advantages are particularly relevant for small nodules, multinodular goitre, partially cystic lesions, and nodules that are

difficult to palpate clinically. The findings of the present study therefore support the preferential use of ultrasound-guided FNAC wherever ultrasound facilities and trained operators are available.

### **Strengths of the Study**

The present study has several important strengths. It employed a prospective comparative design with equal allocation of patients into palpation-guided FNAC and ultrasound-guided FNAC groups, thereby minimizing selection bias and facilitating a balanced comparison between the two techniques. All enrolled patients underwent surgical excision, enabling histopathological examination to serve as the definitive gold standard for assessing the diagnostic performance of both FNAC methods. A uniform FNAC technique was maintained within each study arm, ensuring procedural consistency and reducing operator-related variability. Furthermore, the study comprehensively evaluated multiple diagnostic performance parameters, including sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy, false-negative rate, and inadequate specimen rate, providing a robust assessment of each technique. By directly comparing two commonly employed diagnostic approaches in routine clinical practice, the study generated clinically relevant evidence regarding the relative effectiveness of ultrasound-guided and palpation-guided FNAC in the evaluation of thyroid nodules.

### **Limitations of the Study**

The present study has several limitations that should be considered while interpreting the findings. The study was conducted at a single institution with a relatively small sample size of 50 patients, which may limit the generalizability of the results to the broader population. Furthermore, only patients who underwent surgical management were included, introducing the possibility of selection bias. Subgroup analyses based on nodule size, ultrasonographic characteristics, or Bethesda cytological classification were not performed, as these variables were not incorporated into the original study design. In addition, interobserver variability among cytopathologists was not assessed, and important practical aspects such as procedure duration and cost-effectiveness of the two FNAC techniques were not evaluated. Finally, long-term follow-up of patients with benign cytological diagnoses was beyond the scope of the present study. These limitations should be taken into account when interpreting the study results, and further large-scale, multicentre studies with extended follow-up are warranted to validate the findings.

### **CONCLUSION**

Ultrasound-guided fine needle aspiration cytology demonstrated superior diagnostic performance compared with palpation-guided FNAC in the evaluation of thyroid nodules. Ultrasound guidance achieved higher diagnostic accuracy, greater sensitivity and specificity, improved positive and negative predictive values, fewer false-negative diagnoses, and a lower inadequate specimen rate than conventional palpation-guided aspiration. The ability of ultrasound to provide real-time visualization of the target lesion facilitates precise needle placement and improves specimen adequacy, particularly in small, deep-seated, cystic, complex, or poorly palpable nodules. These findings support the routine use of ultrasound-guided FNAC as the preferred technique for the preoperative cytological evaluation of thyroid nodules wherever appropriate expertise and equipment are available, as it enhances diagnostic confidence, optimizes clinical decision-making, and facilitates appropriate patient management.

### **Clinical Implications**

The findings of the present study have important implications for the evaluation and management of thyroid nodules. Ultrasound-guided fine needle aspiration cytology (USG-FNAC) demonstrated superior diagnostic performance compared with palpation-guided FNAC, resulting in improved sensitivity, specificity, diagnostic accuracy, and specimen adequacy. These advantages can reduce repeat aspirations, minimize false-negative diagnoses, and improve preoperative planning.

Routine use of USG-FNAC should be considered in the following situations:

- Thyroid nodules <1 cm with suspicious ultrasonographic features.
- Deep-seated or posteriorly located nodules.
- Predominantly cystic or heterogeneous nodules.
- Multinodular goitre with multiple target lesions.
- Nodules yielding inadequate or inconclusive cytology on previous aspiration.
- Patients in whom accurate preoperative diagnosis is required to guide surgical decision-making.

Implementation of ultrasound-guided aspiration may improve diagnostic confidence, optimize patient selection for surgery, and reduce unnecessary thyroidectomy for benign lesions<sup>2,13,15,16</sup>.

### **Future Research**

Future multicentre studies involving larger patient populations are required to validate these findings across different healthcare settings. Studies incorporating the Bethesda System for Reporting Thyroid Cytopathology, ultrasound risk stratification systems such as TI-RADS, molecular testing, and cost-effectiveness analyses would further define the role of ultrasound-guided FNAC in contemporary thyroid nodule management<sup>2,9,15,16</sup>.

## **FINAL CONCLUSION**

Ultrasound-guided fine needle aspiration cytology demonstrated superior diagnostic performance compared with palpation-guided FNAC in the evaluation of thyroid nodules. Ultrasound guidance resulted in significantly higher diagnostic accuracy, greater sensitivity and specificity, improved predictive values, fewer false-negative diagnoses, and a lower inadequate specimen rate. The ability of ultrasound to provide real-time visualization of the target lesion enables accurate needle placement and improves specimen adequacy, particularly in small, deep-seated, cystic, or poorly palpable nodules. Based on these findings, ultrasound-guided FNAC should be considered the preferred technique for cytological evaluation of thyroid nodules wherever expertise and equipment are available, as it enhances diagnostic confidence and facilitates appropriate clinical management.

## **DECLARATIONS**

### **Ethics Approval**

The study was conducted after obtaining approval from the Institutional Ethics Committee of Karnataka Institute of Medical Sciences (KIMS) Hubli.

### **Informed Consent**

Written informed consent was obtained from all participants before enrolment.

### **Funding**

No external funding was received for this study.

### **Conflict of Interest**

The authors declare that there are no conflicts of interest.

### **Authors' Contributions**

- Concept and study design: First author
- Data collection: First author
- Data analysis: First author
- Manuscript preparation: First author
- Critical revision: Guide and co-authors
- Final approval: All authors

### **Data Availability**

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

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