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ORIGINAL ARTICLE

Clinical, Ultrasonographic, and Cytopathological Evaluation of Thyroid Swelling: A Cross-Sectional Study

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ABSTRACT

Background: *Thyroid swellings present a frequent clinical challenge, spanning benign goiters to aggressive malignancies. Accurate preoperative differentiation is vital to optimize surgical strategy and curtail unnecessary thyroidectomies, yet concordance among clinical, imaging, and cytological data remains underexplored in resource-limited contexts.* ***Objective:*** *To evaluate the diagnostic utility of clinical examination, ultrasonography, and fine-needle aspiration cytology in characterizing thyroid swellings.* ***Methods & Materials:*** *This prospective cohort study enrolled 53 patients presenting with thyroid swellings at the Department of Otolaryngology, Community Based Medical College Hospital Bangladesh, Mymensingh, from January 2024 to December 2025 via purposive sampling. Each participant underwent standardized clinical assessment, high-resolution ultrasonography, and ultrasound-guided fine-needle aspiration cytology. Cytological results were classified per the Bethesda System. Data were analyzed using SPSS version 23.0.* ***Results:*** *Among 53 patients (mean age 45.2±12.6 years; 37 females), ultrasonography detected solid nodules in 34 cases and cystic components in 19. Cytologically, benign lesions (Bethesda II) constituted 64.2% (n=34), while malignant or suspicious (Bethesda V–VI) accounted for 15.1% (n=8). USG demonstrated 87.5% sensitivity and 82.2% specificity against cytology, with significant predictors including microcalcifications and irregular margins (p<0.05).* ***Conclusion:*** *Clinical assessment alone remains insufficient for comprehensive thyroid characterization. USG and FNAC demonstrate substantial concordance, with USG serving as a reliable non-invasive diagnostic adjunct. Bethesda categorization effectively stratifies malignancy risk, thereby guiding timely surgical referrals in low-resource settings.*

Keywords: *Cytology, Fine-needle aspiration, Malignancy, Thyroid nodule, Thyroid swelling, Ultrasonography.*

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INTRODUCTION

Thyroid swelling is among the most common clinical presentations in endocrine surgical practice worldwide. The superficially located thyroid gland is readily accessible to physical examination, frequently revealing palpable nodules that prompt diagnostic workup. These swellings span a broad pathological spectrum—from benign colloid goiters and hyperplastic nodules to follicular adenomas and aggressive malignancies such as papillary, follicular, and anaplastic thyroid carcinomas. The global burden of thyroid cancer has risen markedly, with an age-standardized incidence rate of 10.1 per 100,000 women and 3.1 per 100,000 men in 2020 [1]. Projections estimate that incident cases will increase from approximately 234,000 in 2019 to over 305,000 by 2030—a nearly 30% rise [2]. This trend underscores the urgent need for accurate preoperative strategies to distinguish benign from malignant lesions. Clinical evaluation remains the initial assessment step. History and physical examination yield valuable clues—rapid growth, vocal cord paralysis, cervical lymphadenopathy, and fixation to surrounding structures raise malignancy suspicion [3]. However, clinical assessment has well-recognized limitations: overlapping presentations between benign and malignant conditions and considerable inter-observer variability in palpation-based characterization make it insufficient as a standalone modality [4]. Thus, adjunctive investigations are essential. High-resolution ultrasonography (USG) is the cornerstone imaging tool for thyroid nodules. It is non-invasive, widely available, cost-effective, and offers real-time data on nodule composition, echogenicity, margins, vascularity, and calcifications [5,6]. Specific sonographic features correlate with malignancy. Microcalcifications are the single most useful criterion, with a specificity of 96.5% [7,8]. Other suspicious features include marked hypoechogenicity, irregular margins, taller-than-wide shape, intranodular vascularity, and extrathyroidal extension [6,9]. The presence of at least one suspicious feature yields a sensitivity of 87.9% for malignancy [5,10]. Risk stratification systems, such as the American Thyroid

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Association (ATA) guidelines and TIRADS, standardize reporting and guide fine-needle aspiration decisions [6,11]. ATA sonographic patterns effectively stratify cancer risk, with distinct outcomes for each pattern [12]. Fine-needle aspiration cytology (FNAC) is the gold standard preoperative test. It is minimally invasive, simple, cost-effective, well-tolerated, and performed in outpatient settings with rapid results [7]. FNAC diagnostic accuracy is well-established, with sensitivity of 85.7–93.3% and specificity of 75.6–98.6% [8]. Its widespread use has significantly reduced unnecessary thyroid surgeries, lowering morbidity and costs [7,8]. Limitations include a non-diagnostic rate of 5–15% and uncertainty in indeterminate categories [11]. The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC), introduced in 2007, standardized cytology reporting with a six-tiered classification: nondiagnostic (Bethesda I), benign (II), atypia of undetermined significance (III), follicular neoplasm (IV), suspicious for malignancy (V), and malignant (VI) [9]. This framework facilitates clear communication among cytopathologists, radiologists, endocrinologists, and surgeons, enabling consistent risk stratification and management guidance [10]. Each Bethesda category carries an estimated malignancy risk, directing decisions from observation to lobectomy or total thyroidectomy [9]. The system has been validated across multiple institutions and geographic settings [10], and aids in managing nondiagnostic or indeterminate nodules with repeat FNAC or molecular testing [11]. USG and FNAC are complementary: USG provides morphological information and guides aspiration, while FNAC offers cytological characterization. Their combined use increases diagnostic accuracy and reduces unnecessary surgeries [7]. Studies show significant associations between USG and FNAC diagnoses, with USG demonstrating 88.7% sensitivity and 70.7% specificity against FNAC as reference [8,12]. In Bangladesh, thyroid swellings are a frequent reason for consultation in otolaryngology and general surgery. While USG and FNAC are increasingly available in tertiary centers, the concordance among clinical, ultrasonographic, and cytopathological findings in the local population remains underexplored. Understanding their diagnostic performance in this context is vital for evidence-based pathways that optimize outcomes while conserving scarce resources. This prospective cohort study was therefore undertaken to evaluate the clinical, ultrasonographic, and cytopathological characteristics of thyroid swellings in patients presenting to a tertiary care hospital in Bangladesh, and to assess the diagnostic utility of these modalities in characterizing thyroid pathology.

METHODS & MATERIALS

This prospective cohort study was conducted at the Department of Otolaryngology, Community Based Medical College Hospital Bangladesh, Mymensingh, from January 2024 to December 2025. A total of 53 patients presenting with clinically detectable thyroid swellings were enrolled using a purposive sampling technique.

Inclusion criteria: Patients of either gender, aged 18 years and above, presenting with palpable thyroid swelling and providing written informed consent were included in the study.

Exclusion criteria: Patients with recurrent thyroid swellings, those who had undergone previous thyroid surgery, pregnant women, and individuals with bleeding diathesis or on anticoagulant therapy were excluded from the study. Patients with inadequate or non-diagnostic cytological samples were also excluded.

Study procedure: All enrolled patients underwent a comprehensive clinical evaluation, including detailed history-taking and physical examination of the thyroid swelling. Subsequently, each patient underwent high-resolution ultrasonography (USG) using a 7–12 MHz linear array transducer (Mindray DC-70, Shenzhen, China). Nodules were characterized based on composition, echogenicity, margins, shape, vascularity, and the presence of calcifications. Ultrasound risk stratification was performed according to the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) guidelines [13]. Following USG, ultrasound-guided fine-needle aspiration cytology (FNAC) was performed using a 23-gauge needle attached to a 10-mL syringe. Aspirated material was smeared onto glass slides, air-dried, and stained with May-Grünwald-Giemsa, while alcohol-fixed smears were stained with Papanicolaou for cytological evaluation. Cytological diagnoses were categorized according to the Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) [14].

Data analysis: All data were recorded in a predesigned case record form and analyzed using Statistical Package for Social Sciences (SPSS) version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation for continuous variables and frequencies with percentages for categorical variables. The diagnostic performance of USG was evaluated against FNAC as the reference standard, calculating sensitivity, specificity, positive predictive value, and negative predictive value. Associations between categorical variables were assessed using the Chi-square test, with a p-value <0.05 considered statistically significant.

RESULT

Among the 53 enrolled patients, the mean age was 45.2 ± 12.6 years, with a range of 18 to 72 years. The majority of patients were female, comprising 37 (69.8%) of the cohort, while males accounted for 16 (30.2%). The most frequently affected age group was 30 to 50 years, representing 28 patients (52.8%). Regarding symptom duration, 33 patients (62.3%) presented with thyroid swelling persisting for more than six months, whereas 20 patients (37.7%) had a shorter duration of less than six months. Clinically, the majority of swellings were painless, observed in 45 patients (84.9%), while pain was reported in only 8 cases (15.1%). Hoarseness of voice was noted in 6 patients (11.3%), and dysphagia was present in 5 patients (9.4%). Rapid growth of the swelling was documented in 4 patients (7.5%), prompting early clinical concern for malignant transformation. Ultrasonographic evaluation revealed solid nodules in 34 patients (64.2%), mixed solid-cystic lesions in 12 patients (22.6%), and purely cystic lesions in 7 patients (13.2%). In terms of echogenicity, hypoechoic nodules were the most prevalent, identified in 33 patients (62.3%), followed by isoechoic nodules in 15 patients (28.3%) and hyperechoic nodules in 5 patients (9.4%). Regular margins were observed in 38 cases (71.7%), while irregular or ill-defined margins were noted in 15 cases (28.3%). Microcalcifications were detected in 10 patients (18.9%), macrocalcifications in 8 patients (15.1%), and no calcifications in the remaining 35 patients (66.0%). According to the ACR TI-RADS stratification, the distribution was as follows: TR 1-2 in 10 patients (18.9%), TR 3 in 15 patients (28.3%), TR 4 in 18 patients (34.0%), and TR 5 in 10 patients

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(18.9%). Cytological categorization using the Bethesda System yielded the following distribution: Bethesda I (nondiagnostic) in 2 patients (3.8%), Bethesda II (benign) in 34 patients (64.2%), Bethesda III (atypia of undetermined significance) in 5 patients (9.4%), Bethesda IV (follicular neoplasm) in 4 patients (7.5%), Bethesda V (suspicious for malignancy) in 3 patients (5.7%), and Bethesda VI (malignant) in 5 patients (9.4%). Combining the suspicious and malignant categories (Bethesda V–VI) yielded a total of 8 patients (15.1%) with a cytological diagnosis suspicious or positive for malignancy, whereas the remaining 45 patients (84.9%) were classified as benign or indeterminate. When comparing USG findings with FNAC as the reference standard, ultrasonography demonstrated a sensitivity of 87.5% and a specificity of 82.2% for detecting malignant thyroid lesions. The positive predictive value was 46.7%, and the negative predictive value was 97.4%, indicating that USG is highly effective in ruling out malignancy when findings are benign. Further analysis of specific sonographic features revealed that irregular margins and the presence of microcalcifications were significantly associated with malignant cytology (Bethesda V–VI). Patients with irregular margins had a markedly higher proportion of malignancy compared to those with regular margins. Similarly, microcalcifications demonstrated a strong correlation with malignant outcomes. However, age greater than 50 years, male gender, and hypoechogenicity did not show statistically significant associations with malignancy in this cohort.

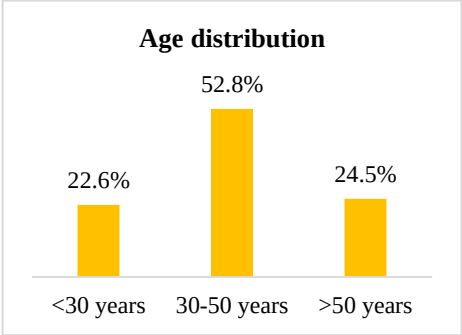

Figure 1 Age Distribution of Participants (*n*=53).

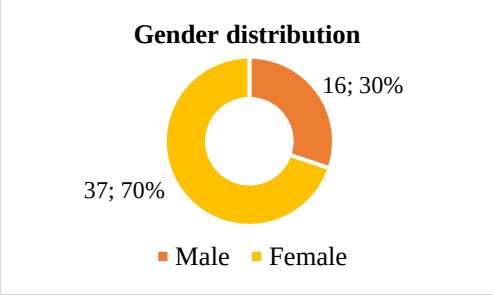

Figure 2 Gender Distribution of Participants.

Table I
Clinical Presentation of Thyroid Swellings.

Clinical Feature	n	%
Painless swelling	45	84.9
Painful swelling	8	15.1
Hoarseness of voice	6	11.3
Dysphagia	5	9.4
Rapid growth	4	7.5

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Table II
Ultrasonographic Characteristics of Thyroid Swellings.

Feature	Category	n (%)
Composition	Solid	34 (64.2)
	Mixed (solid-cystic)	12 (22.6)
	Cystic	7 (13.2)
Echogenicity	Isoechoic	15 (28.3)
	Hypoechoic	33 (62.3)
	Hyperechoic	5 (9.4)
Margins	Regular	38 (71.7)
	Irregular/ill-defined	15 (28.3)
Calcifications	Microcalcifications	10 (18.9)
	Macrocalcifications	8 (15.1)
	None	35 (66.0)
ACR TI-RADS Category	TR 1 – 2 (Benign)	10 (18.9)
	TR 3 (Mildly suspicious)	15 (28.3)
	TR 4 (Moderately suspicious)	18 (34.0)
	TR 5 (Highly suspicious)	10 (18.9)

Table III
Distribution of Cytological Diagnoses According to the Bethesda System.

Bethesda Category	n	Percentage (%)
Bethesda I – Nondiagnostic	2	3.8
Bethesda II – Benign	34	64.2
Bethesda III – AUS/FLUS	5	9.4
Bethesda IV – Follicular neoplasm	4	7.5
Bethesda V – Suspicious for malignancy	3	5.7
Bethesda VI – Malignant	5	9.4
Total	53	100

Table IV
Correlation between USG (ACR TI-RADS) and FNAC (Bethesda) for Malignancy Detection.

USG Findings	Malignant (Bethesda V–VI)	Benign (Bethesda I–IV)	Total
Suspicious (TR 4 – 5)	7	8	15
Benign (TR 1 – 3)	1	37	38
Total	8	45	53

Statistical test: Chi-square test ($\chi^2 = 16.30$, $df = 1$, $p = 0.000$).

Table V
Association of Clinico-Sonographic Features with Malignant Cytology (Bethesda V–VI).

Feature	Category	Total (n)	Malignant (n, %)	Benign (n, %)	p-value
Age	> 50 years	13	4 (30.8)	9 (69.2)	0.087
	≤ 50 years	40	4 (10.0)	36 (90.0)	
Gender	Male	16	3 (18.8)	13 (81.2)	0.532
	Female	37	5 (13.5)	32 (86.5)	
Margins	Irregular	15	6 (40.0)	9 (60.0)	0.001
	Regular	38	2 (5.3)	36 (94.7)	
Microcalcifications	Present	10	5 (50.0)	5 (50.0)	0.001
	Absent	43	3 (7.0)	40 (93.0)	
Hypoechogenicity	Present	33	6 (18.2)	27 (81.8)	0.419
	Absent	20	2 (10.0)	18 (90.0)	

Statistical test: Chi-square test (Fisher's exact test applied where any expected cell count was <5).

DISCUSSION

This prospective cohort study (n=53) evaluated clinical examination, ultrasonography (USG), and fine-needle aspiration cytology (FNAC) for characterizing thyroid swellings in a Bangladeshi tertiary care setting. Clinical assessment offers preliminary data, yet USG and FNAC provide complementary diagnostic information with substantial concordance, and specific sonographic features significantly predict malignant cytology. The cohort exhibited female predominance (69.8%) and a mean age of 45.2 years, aligning with established epidemiological patterns (female-to-male ratios 3:1–5:1) [15,16] and peak incidence in the 30–50-year age group, consistent with other Asian cohorts [17]. Ultrasonography demonstrated 87.5% sensitivity and 82.2% specificity against FNAC as the reference. These results are comparable to published figures of 88.6%/70.7% [8] and

77.4%/94.1% [14]. The higher specificity observed here may reflect ACR TI-RADS application, which enhances specificity at the expense of some sensitivity [10]. The 97.4% negative predictive value (NPV) is particularly notable, matching the 95.7% NPV reported for ACR TI-RADS in a large study [18], confirming that benign USG findings effectively exclude malignancy. This high NPV underscores the utility of USG as a reliable triage tool in the diagnostic algorithm. Bethesda classification revealed benign (II) lesions as the majority (64.2%), while malignant or suspicious categories (V–VI) comprised 15.1%. This distribution is broadly consistent with published series, where benign cytology typically represents 60–70% [11]. The 15.1% malignancy rate slightly exceeds the 9.1% reported in a recent Indian cross-sectional study [19], possibly reflecting referral patterns. Notably, the nondiagnostic rate was only 3.8%, favorable compared to the 5–15% literature average [13], likely attributable to routine ultrasound-guided aspiration [20]. This low rate compares favorably with international benchmarks and reinforces the value of real-time guidance in improving specimen adequacy. Irregular margins and microcalcifications were significantly associated with malignant cytology (p=0.001 for both), corroborated by recent evidence [17,21]. Microcalcifications remain the most useful criterion, exhibiting 96.5% specificity [7]. The combined use of USG and FNAC demonstrated robust concordance, consistent with guidelines recommending USG to guide FNAC decisions while cytology provides definitive preoperative diagnosis [12]. Implementing ACR TI-RADS standardized reporting can reduce unnecessary FNAC procedures by 20–30% without sacrificing diagnostic accuracy [22]. Key limitations include the small sample size (n=53), which precludes detailed subgroup analyses; the lack of surgical histopathological confirmation for all patients, relying instead on FNAC as the reference (though FNAC itself is highly accurate [23]); purposive sampling introducing selection bias; and the single-center design, which limits generalizability to primary care settings. Conversely, strengths include the prospective design, standardized data collection using predefined criteria, and the application of internationally validated classification systems [14,24]. The high NPV of USG carries particular clinical relevance in resource-limited environments, enabling safe sonographic surveillance without immediate FNAC for lesions with benign features [25]. In summary, clinical assessment alone proves insufficient for comprehensive thyroid characterization. Both USG and FNAC play indispensable, complementary roles. Irregular margins and microcalcifications are strong malignancy predictors and should trigger cytological evaluation. Given its high NPV, USG serves as an effective screening tool to optimize resource allocation in Bangladesh. Future large-scale, multicenter studies incorporating histopathological correlation are strongly recommended to further validate these findings.

LIMITATIONS

The study has limitations including a relatively small sample size, single-center design, and purposive sampling technique. The absence of surgical histopathological confirmation for all patients, relying on FNAC as the reference, may have introduced verification bias. Furthermore, the findings may not be generalizable to primary care settings.

CONCLUSION

Clinical examination alone is insufficient for comprehensive thyroid characterization. Ultrasonography demonstrates an excellent negative predictive value, effectively ruling out malignancy, while fine-needle aspiration cytology with Bethesda System categorization provides definitive preoperative risk stratification. Irregular margins and micro calcifications are significant independent predictors of malignant cytology. The integrated use of ACR TI-RADS and Bethesda classification optimizes diagnostic accuracy and guides timely surgical intervention, particularly in resource-limited settings like Bangladesh.

RECOMMENDATION

Routine ultrasonography should be employed as the primary triage tool before FNAC for thyroid swellings, utilizing ACR TI-RADS for standardized reporting. Large-scale, multicenter studies with histopathological correlation are warranted to further validate these findings and refine risk stratification.

CONFLICT OF INTEREST

The authors declare no conflicts of interest. No funding was received for this study. The corresponding author had full access to all data and final responsibility for the decision to submit for publication.

AI DECLARATION

Artificial intelligence tools contributed marginally to manuscript preparation and development. All core scientific content was human-verified.

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