International Journal of Medicine and Medical Research

Journal homepage: https://ijmr.com.ua/
Volume 9, No. 2. 2023

UDC 616.44-006.6:577.2
DOI: 10.61751/ijmmr/2.2023.51

Article's History:
Received: 10.08.2023; Revised: 31.10.2023; Accepted: 28.11.2023

Cytological study of different thyroid lesions and its correlation with thyroid function test

Ruchi Yadav*
Bachelor of Medicine, Bachelor of Surgery, Junior Resident
Baba Raghav Das Medical College
273013, Gorakhpur, Uttar Pradesh, India
https://orcid.org/0009-0006-1899-0120

Shaila Mitra
Doctor of Medicine, Professor
Baba Raghav Das Medical College
273013, Gorakhpur, Uttar Pradesh, India
https://orcid.org/0009-0007-4719-9714

Rajesh Rai
Doctor of Medicine, Professor
Baba Raghav Das Medical College
273013, Gorakhpur, Uttar Pradesh, India
https://orcid.org/0009-0009-5017-7502

Abstract. The research relevance of the combined use of fine needle aspiration cytology, sonography, and thyroid function tests is determined by accurate diagnostics of thyroid enlargement in both adults and children. The study aimed to analyse thyroid lesions through cytological analysis and their correlation with thyroid function test results. This cross-sectional study enrolled 100 patients with suspected thyroid disorders and nodules. Comprehensive assessments included clinic demographics, fine needle aspiration cytology procedures, and thyroid hormone profiles. Based on the Bethesda system, cytological diagnoses were correlated with thyroid function test results using the chemiluminescent microparticle immunoassay method. Non-tumour thyroid lesions were found to be the most common (95%), with colloidal goitre being the most common. Neoplastic cases mainly included papillary and follicular carcinoma. Most thyroid lesions occurred among the 21-30 age group, non-neoplastic cases were more frequent among the 10-20 age group, and neoplastic cases were more common in those aged 21-40. All patients had neck swelling. Most cases were euthyroid (76%), predominantly classified as Category 2. A strong correlation between cytological diagnoses and thyroid hormone levels (p=0.04) was observed. Fine needle aspiration cytology demonstrated good sensitivity (80%) and high specificity (98.46%), with an 80% positive predictive value and 98.46% negative predictive value, resulting in a diagnostic accuracy of 97.14%. The study highlights the valuable role of fine needle aspiration cytology, when coupled with thyroid function tests, in effectively guiding the management of patients with thyroid lesions, owing to its impressive accuracy, sensitivity, and specificity

Keywords: fine needle aspiration cytology; Bethesda system; thyroid; cytologyhistopathology

Suggest Citation:
Yadav R, Mitra S, Rai R. Cytological study of different thyroid lesions and its correlation with thyroid function test. Int J Med Med Res. 2023;9(2):51–62. DOI: 10.61751/ijmmr/2.2023.51

*Corresponding author

Introduction

Thyroid enlargement, or goitre, is a common disease, affecting 4-7% of adults and 0.2-1.8% of children. In India, 42 million people have thyroid disorders, with thyroid cancer being relatively rare [1, 2]. The absolute rates of thyroid carcinoma in females were four times those diagnosed in males. However, the thyroid cancer-specific mortality rate has remained stable [3]. Most swellings are benign, but 10-20% can be malignant. R.A. McPherson & M.R. Pincus [1] reported that detection of thyroid nodules is crucial, as 7-15% of cases may be cancerous, depending on various factors. Thyroid diseases are categorised as hyperthyroid, hypothyroid, or euthyroid based on clinical features and hormone profiles. Subtle symptoms often necessitate biochemical testing and cytological evaluation for diagnosis [4]. Iodine deficiency, affecting a third of the global population, causes goitre and, in severe cases, congenital hypothyroidism, as noted by A. Hatch-McChesney & H.R. Lieberman [5]. Thyroid cancer accounts for 2% of all cancers and 95% of endocrine cancers, with an increasing incidence, primarily due to small papillary thyroid cancers (≤2 cm) [6]. The thyroid parenchyma consists of two major cell types, the thyroid follicular cells that cause differentiated thyroid cancer (DTC) and the parafollicular or C-cells that are genesis to medullary thyroid carcinoma. DTC includes papillary thyroid cancer, follicular thyroid cancer and Hurthle cell cancer, accounting for 90-95% of all thyroid malignancies. Medullary thyroid carcinoma accounts for around 1 to 2%, and anaplastic thyroid carcinoma accounts for less than 1% of all thyroid cancers. From 1998-2012, the incidence of papillary thyroid cancer increased worldwide, mostly due to early detection and advanced imaging technology with the risk of overdetection [6]. Fine needle aspiration cytology (FNAC) is the gold standard for evaluating thyroid nodules, with high sensitivity and positive predictive value. FNAC is a minimally invasive, accurate, and cost-effective screening test. It bridges the gap between clinical evaluation and surgical diagnosis, reducing unnecessary surgeries [7]. FNAC should be used with thyroid hormone status assessment, including serum thyroid function tests (TSH) levels. P. Petranović Ovčaričeк *et al.* [8] determined that higher TSH levels, even within the upper reference range, indicate an increased risk of malignancy and advanced thyroid cancer. V. Jain *et al.* [9] reported that FNAC, alongside thyroid function test, can be used for early and accurate diagnosis of various thyroid lesions, and reduces unnecessary intervention. Routine FNAC screening has reduced unnecessary thyroidectomies for benign thyroid diseases [10]. H.E. Yazdaan *et al.* [11] reported that thyroid function tests are essential in evaluating risk and prognosis, specifically thyroid nodules, and thyroid cancer. Furthermore, S.K.C. Mishra *et al.* [12] demonstrated that the euthyroid state was more common than hypothyroid and hyperthyroid states for both non-neoplastic and neoplastic conditions. A clear interpretation of FNAC results is crucial. The National Cancer Institute's "The Bethesda System for Reporting Thyroid Cytopathology" (TBSRTC) provides a useful reporting system for thyroid fine needle aspirates and management guidelines for follow-up or surgery [10]. FNAC in conjunction with the thyroid hormonal profile helps assess the disease stage and determine the treatment option for the patient. This study aimed to assess the cytological findings of palpable thyroid nodules in conjunction with the thyroid hormonal profile of the patient.

Materials and Methods

In this cross-sectional study, conducted at the Department of Pathology, patients seeking FNAC for thyroid lesions at the Department of Ear, Nose, and Throat (ENT) at Nehru Chikitsalay, B.R.D Medical College, were examined from July 2020 to June 2021. Ethical clearance and informed consent were obtained. This study enrolled 100 patients with clinical suspicion of thyroid disorders and thyroid nodules, excluding those with inadequate samples. Demographic information for all participants was documented, a process that involved participants disclosing their demographic details involved a questionnaire or during an initial consultation with healthcare professionals participating in the study. An exhaustive medical history was then compiled, encompassing details of participants' illnesses, including symptoms and their duration. Participants were queried regarding any prior thyroid-related ailments or pertinent medical conditions, as well as familial history of thyroid disorders. A comprehensive physical examination was conducted before FNAC to evaluate factors such as nodule size, mobility, consistency, and the presence of cervical lymph nodes. This examination entailed an assessment of each participant's thyroid gland and its adjacent structures. Additionally, healthcare providers palpated the thyroid gland to discern any tenderness or nodularity. The findings from this examination provided clinical insights into the nature and attributes of thyroid lesions in each participant. These procedures provided information on participants' demographic profiles, clinical manifestations, and physical examination outcomes, all of which are indispensable for precise diagnosis and effective management of thyroid disorders.

Routine investigations and serum triiodothyronine (T3), serum thyroxine (T4), and TSH levels were noted. FNAC procedures were performed using aspiration and non-aspiration techniques with a 23/24-gauge needle and a 10 mL syringe. Multiple smears were prepared from 2-6 sites within the lesion and stained using haematoxylin and eosin (H&E) and May-Grunwald Geimsa (MGG) techniques. In the H&E staining process, slides were first immersed in haematoxylin solution to impart a blue-purple hue to the cellular nuclei. This was followed by a brief rinse in acidic alcohol to differentiate nuclei from other cellular components. Subsequently, slides were counterstained with eosin, which imparted a pink colouration to the cytoplasm, facilitating the identification of cellular structures and abnormalities. Concurrently, MGG staining was employed to enhance the contrast and resolution of cellular components. This multi-step staining method

involved successive immersion of slides in May-Grünwald stain, Giemsa stain, and buffer solutions. May-Grünwald stain was used to fix cellular components and impart an initial staining, while Giemsa stain further enhanced cellular details by selectively staining components such as nuclei, cytoplasm, and cellular inclusions. Once stained, the slides were thoroughly rinsed, air-dried, and covered slipped for microscopic examination. The dual staining approach provided comprehensive visualization of cellular morphology and accurate identification and characterization of various thyroid lesions. This cytological processing protocol, incorporating both H&E and MGG staining techniques, ensured high-quality cytological evaluations crucial for correlating with thyroid function tests and guiding effective patient management strategies. In the case of cystic lesions, fluid was first aspirated, followed by nodule re-aspiration. In the case of cystic swellings, the aspirated fluid was centrifuged, and sediment smears were prepared. Experienced pathologists examined all slides at various magnifications. Final FNAC diagnoses were made, and the cytology slides were reported using the Bethesda system [13]. Hormone profile samples, including serum TSH, T4, and T3, were obtained and analysed using the chemiluminescent microparticle immunoassay (CMIA) method. CMIA is an advanced variation of the enzyme-linked immunosorbent assay (ELISA). Reference ranges for the study were as follows: TSH: 0.3-4.9 uIU/mL; T4: 4.8-11.7 ug/dL; T3: 0.3-4.9 ng/mL.

The study involving human subjects adhered to ethical principles outlined in the Declaration of Helsinki [14] and applicable national and institutional guidelines. Informed consent was obtained from all participants, detailing the study purpose, procedures, potential risks, and benefits. Patient confidentiality and data protection were strictly maintained throughout the experiment. The study received ethical approval from the Institutional Ethical Review Board.

Statistical Analysis:

Cytomorphological details, FNAC diagnoses, and TFT results were recorded in Microsoft Excel 2016, and statistical analysis was conducted using SPSS 27. This study collected all relevant data and applied appropriate statistical methods for analysis, including data sorting, tabulation, and visual representation through pie diagrams and histograms. Statistical techniques, such as p-value calculation and the chi-square test, were used to assess the study's significance. Initially, data collection procedures were implemented to retrieve cytologic and histopathological information. Subsequently, cases were classified into true positive (TP), true negative (TN), false positive (FP), and false negative (FN) categories based on the agreement or discrepancy between cytologic and histopathological diagnoses. A professional statistician was consulted to interpret the results, and a significance threshold of $p<0.05$ was established.

Results

In a recent study, 100 cases with thyroid swelling underwent cytological evaluation, with diagnoses aligned with the Standard Nomenclature of the Bethesda System. The average patient age was 32.76 years, with the highest incidence of thyroid lesions in the 21-30 age group (27%). Table 1 demonstrates the prevalence of non-neoplastic cases over neoplastic cases. Within the non-neoplastic category, the 10-20 age group had the highest percentage (27.37%), followed by the 21-30 and 31-40 age groups. Conversely, neoplastic cases were primarily concentrated in the 21-40 age group, representing 60% of such cases, while the 41-60 and 61-80 age groups contributed 20% each. Gender-wise, females demonstrated a higher incidence of cases, constituting 88% of the total, compared to males who made up the remaining 12%. Lastly, examining the residence distribution, the majority of cases (78%) were reported in urban areas, with rural areas accounting for the remaining 22%. The comprehensive analysis of the table provided valuable insights into the demographic characteristics of the cases, offering a foundation for further investigation and public health planning.

The non-neoplastic thyroid lesions accounted for the majority at 95%. In comparison, 5% were categorised as neoplastic (Fig. 1).

Table 1. Demographic parameters of enrolled patients (N=100)

Age (years) (all cases)	N	%
10-20	26	26
21-30	27	27
31-40	19	19
41-50	14	14
51-60	9	9
61-70	4	4
71-80	1	1
Non-neoplastic cases		
10-20	26	27.37
21-30	25	26.31
31-40	18	18.95
41-50	14	14.74
51-60	8	8.42
61-70	3	3.16
71-80	1	1.05

Continued Table 1

Age (years) (all cases)	N	%
Neoplastic cases		
0-20	0	0
21-40	3	60
41-60	1	20
61-80	1	20
Gender		
Male	12	12
Female	88	88
Total	100	100
Residence		
Rural	22	22
Urban	78	78

Source: compiled by the authors

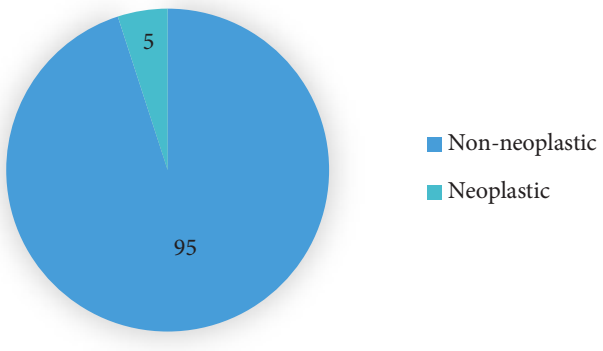

Figure 1. Distribution of cases based on neoplastic and non-neoplastic lesions
Source: compiled by the authors

According to the Bethesda classification, the data revealed that Category 1 (non-diagnostic) had no instances, constituting 0% of the cases. Category 2 (benign) comprised the majority, accounting for 95% of the cases, suggesting a prevalent benign nature of the observed conditions. Category 3 (atypia of undetermined significance) and Category 5 (suspicious for malignancy) both showed no occurrences, representing 0% in the past data. Within the Bethesda system, Category 4 (follicular neoplasm) constituted 2% of the cases, indicating a relatively low but existing prevalence of follicular neoplasms. Category 6 (malignant) had a presence in 3% of the cases, indicating instances where malignant conditions were identified cytologically. This comprehensive analysis of the past data according to Bethesda categories provides valuable insights into the distribution of cytological findings, aiding in understanding the nature of thyroid lesions and guiding further clinical management and investigation (Table 2).

Table 2. Distribution of thyroid lesions according to the Bethesda classification system

Bethesda category	N	%
Category 1 (non-diagnostic)	00	0
Category 2 (benign)	95	95
Category 3 (atypia of undetermined significance)	00	0
Category 4 (follicular neoplasm)	02	2
Category 5 (suspicious for malignancy)	00	0
Category 6 (malignant)	03	3

Source: compiled by the authors

Among the non-neoplastic lesions, Colloid Goitre was the most prevalent, constituting 72% of the cases. Autoimmune Thyroiditis accounted for 16%, while Lymphocytic Thyroiditis, Hyperplastic Nodule, and Colloid Cyst each contributed 3% and 2% to the cases, respectively.

Within the neoplastic lesions category, Follicular Neoplasm and Papillary Carcinoma each represented 2% of the cases. Medullary Carcinoma had a presence in 1% of the cases. This highlights the diverse spectrum of thyroid lesions encountered, emphasizing the prominence of

non-neoplastic lesions such as Colloid Goitre and providing insights into the relative occurrence of various neoplastic entities, including Follicular Neoplasm, Papillary Carcinoma, and Medullary Carcinoma.

This is crucial for clinicians and researchers to understand the prevalence and distribution of thyroid lesions for effective diagnostic and therapeutic strategies (Table 3).

Table 3. Distribution of various thyroid lesions by the conventional method

Thyroid lesions	N	%
Non-Neoplastic lesion		
Colloid Goitre	72	72
Autoimmune Thyroiditis	16	16
Lymphocytic Thyroiditis	3	3
Hyperplastic Nodule	2	2
Colloid Cyst	2	2
Neoplastic lesion		
Follicular Neoplasm	2	2
Papillary Carcinoma	2	2
Medullary Carcinoma	1	1

Source: compiled by the authors

All patients had neck swelling, suggesting a high prevalence of conditions or disorders characterised by neck swelling within the studied population. Other symptoms included weight loss, weight gain, palpation and anxiety, fever, cold intolerance, dysphagia, or difficulty in swallowing, change in voice, and neck pain contributing to 3%, 4%, 1%, 2%, 9%, 3%, 4%, 5%, and 6% of the cases, respectively. These findings highlight the diversity of symptoms experienced by the individuals under consideration, with a spectrum of manifestations ranging from physical signs, such as exophthalmos, to more subjective symptoms such as palpation and anxiety. Understanding the prevalence and distribution of these symptoms is crucial for healthcare professionals in diagnosing and managing the underlying conditions, and it forms the basis for further clinical investigation and intervention (Fig. 2).

Among the cases, 36% had diffuse thyroid swelling, while 64% had nodular thyroid swelling (Fig. 3).

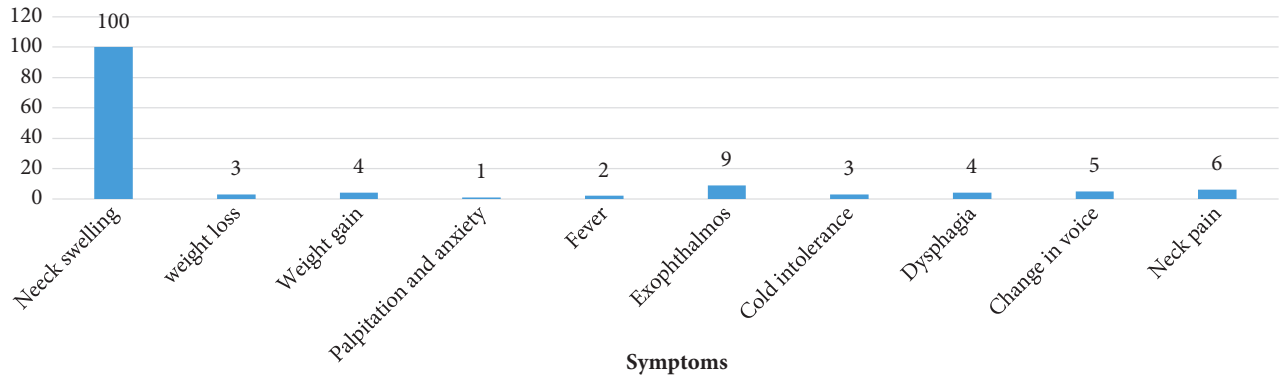

Figure 2. Presenting symptoms of the enrolled cases

Source: compiled by the authors

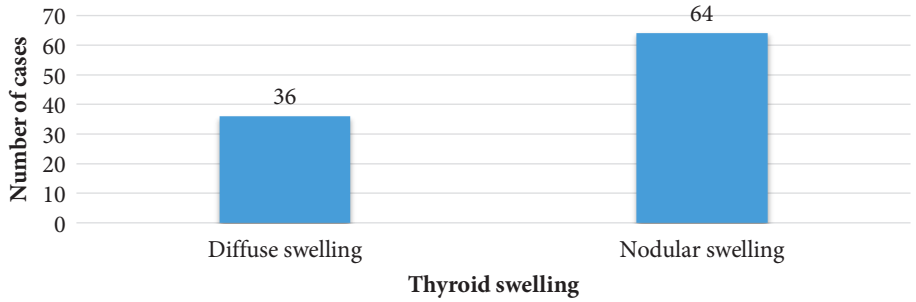

Figure 3. Type of thyroid swelling among the enrolled cases

Source: compiled by the authors

The most prevalent lesion was Colloid Goitre, constituting 75.79% of the total cases. This suggests a significant predominance of Colloid Goitre within the cohort, indicating a prevalent non-neoplastic thyroid condition characterised by the enlargement of thyroid tissue. Autoimmune Thyroiditis was the second most common lesion, representing 16.85% of the cases. This finding underscores the presence of autoimmune-mediated inflammation of the thyroid gland within the studied population. Lymphocytic Thyroiditis, Hyperplastic Nodule, and Colloid Cyst contributed to 3.16%, 2.10%, and 2.10% of the cases, respectively, highlighting the diversity of thyroid lesions observed. In total, the combined percentage of cases accounted for 100% of the studied cohort, providing a comprehensive overview of the prevalence and distribution of different thyroid lesions (Fig. 4).

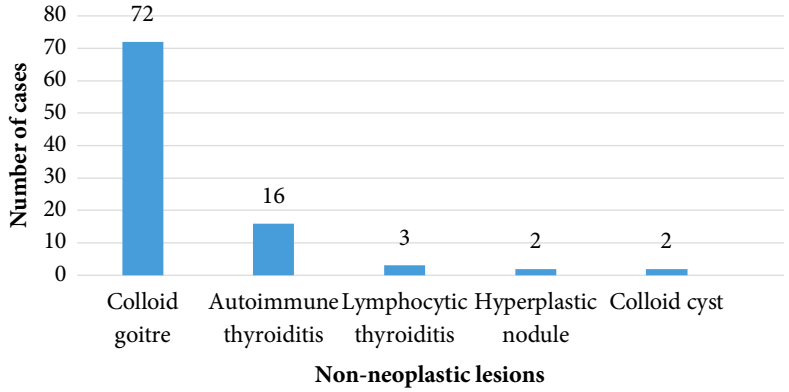

Figure 4. Type of non-neoplastic lesions among the enrolled cases
Source: compiled by the authors

Among the observed cases, Papillary Carcinoma and Follicular Neoplasm were equally prevalent, each constituting 40% of the total cases. This suggests a notable occurrence of these two neoplastic lesions within the studied population, highlighting the significance of both Papillary Carcinoma and Follicular Neoplasm as contributors to thyroid pathology. Medullary Carcinoma, while less frequent, represented 20% of the cases. This indicates a proportion of individuals within the cohort presenting with this specific type of thyroid carcinoma (Fig. 5).

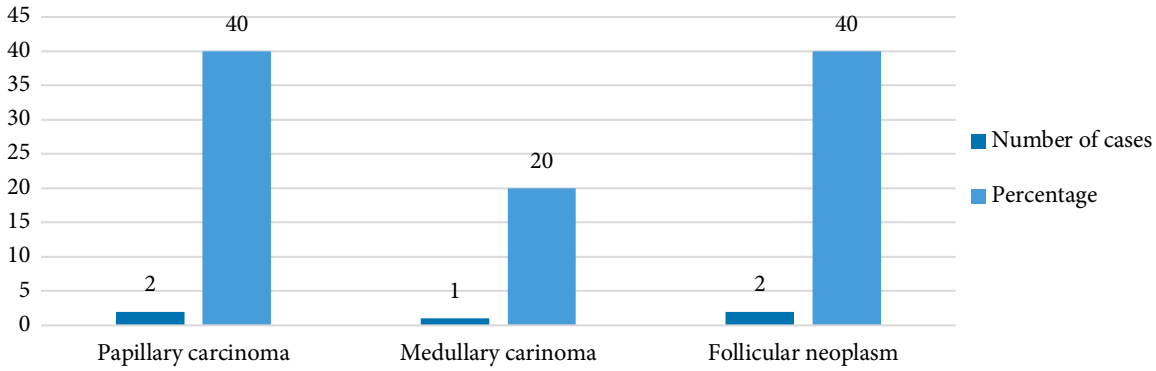

Figure 5. Type of neoplastic lesions among the enrolled cases
Source: compiled by the authors

In terms of thyroid hormone profiles, the majority of cases were classified as Euthyroid, constituting 76% of the group. This indicates a prevalent state of normal thyroid function within the studied population, where the thyroid gland is functioning within the normal range, and hormone levels are balanced. Hypothyroid cases accounted for 20%, reflecting individuals with an underactive thyroid, a condition characterised by insufficient thyroid hormone production. On the other hand, Hyperthyroid cases represented 4% of the total, suggesting a minority of individuals with an overactive thyroid gland, leading to an excess of thyroid hormones. Comprehension of the prevalence of different thyroid statuses is crucial for healthcare professionals in diagnosing and managing thyroid disorders, as it helps determine appropriate treatment strategies based on the specific thyroid status of individuals within a given group (Fig. 6).

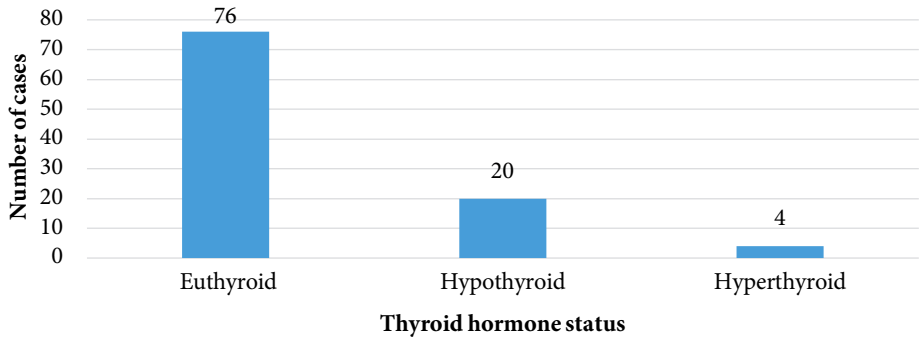

Figure 6. Thyroid hormone status among the enrolled cases
Source: compiled by the authors

Among the 95 cases classified as non-neoplastic lesions, the distribution of thyroid statuses varied significantly across different lesion types. For Colloid Goitre, the majority of cases were Euthyroid (60 cases), with 9 cases classified as Hypothyroid and 3 as Hyperthyroid. The Chi-squared test revealed a prominent relation between Colloid Goitre and thyroid status (p=0.04), suggesting that the thyroid status of individuals with Colloid Goitre differed significantly from the expected distribution. Similarly, for Autoimmune Thyroiditis, the majority of cases were Hypothyroid (10 cases), with 5 Euthyroid and 1 Hyperthyroid case. Lymphocytic Thyroiditis and Hyperplastic Nodules showed a predominantly Euthyroid distribution. The neoplastic lesions, including Follicular Neoplasm, Papillary Thyroid Carcinoma, and Medullary Carcinoma, were all associated with Euthyroid status (Table 4).

Table 4. Correlation between thyroid lesions and hormone profiles

Non-Neoplastic lesions (N=95)	Euthyroid	Hypothyroid	Hyperthyroid	p-value
Colloid Goitre	60	9	3	
Autoimmune Thyroiditis	5	10	1	
Lymphocytic Thyroiditis	2	1	0	
Hyperplastic Nodule	2	0	0	
Colloid Cyst	2	0	0	Chi^2 =24.67 p= 0.04
Neoplastic lesions (N=5)				
Follicular Neoplasm	2	0	0	
Papillary Thyroid Carcinoma	2	0	0	
Medullary Carcinoma	1	0	0	

Notes: Chi^2 = 24.67 (p = 0.04) indicates a strong association between thyroid lesion type and thyroid status
Source: compiled by the authors

Histopathological examination was available for 70 cases. Among non-neoplastic lesions, 61 cases initially diagnosed as Colloid Goitre on FNAC were histopathologically examined, with 60 cases confirming benign status and 1 indicating malignancy. Hyperplastic Nodule and Colloid Cyst, both benign lesions, demonstrated complete concordance between cytological and histopathological evaluations, with all cases being consistently classified as benign. Follicular Neoplasm exhibited a more complex pattern, with two cases initially classified as benign cytologically later revealing malignancy upon histopathological examination. Papillary Carcinoma and Medullary Carcinoma, malignant lesions, showed concordance between the two diagnostic methods, with all cases being consistently identified as malignant. These findings highlight the importance of combining both cytological and histopathological assessments for accurate diagnosis and subsequent management of thyroid lesions. The discrepancies observed in certain cases highlight the challenges in accurately characterizing lesions based on cytological evaluation alone, emphasizing the need for a comprehensive approach to ensure optimal clinical decision-making and patient care (Table 5).

Table 5. Cyto-histopathological correlation of lesions of thyroid

Lesions	Cytology	Histopathology	
		Benign	Malignant
Colloid Goitre	61	60	1
Hyperplastic nodule	2	2	0
Colloid cyst	2	2	0
Follicular neoplasm	2	1	1
Papillary carcinoma	2	0	2
Medullary carcinoma	1	0	1

Source: compiled by the authors

Among the cases classified as cytologically benign, most of the 64 cases were consistent with histopathology (true negative), indicating accurate identification of benign lesions. However, one case was falsely classified as benign cytologically but revealed malignancy upon histopathological examination (false negative). For cytologically malignant cases, four cases were consistent with histopathology (true positive), accurately identifying malignant lesions. However, there was one case classified as malignant cytologically that was later determined to be benign upon histopathological examination (false positive). In total, out of the 70 cases, 68 were consistent with histopathology, showcasing the reliability of cytological diagnoses, while 2 cases showed inconsistencies between cytology and histopathology (Table 6).

Table 6. Relation between cytologic and histopathological diagnosis

Lesion	Consistent with histopathology	Inconsistent it histopathology	Total
Cytologically benign	64 (True negative)	1 (False negative)	65
Cytologically malignant	4 (True positive)	1 (False positive)	5
Total	68	2	70

Source: compiled by the authors

In the study of 100 cases of thyroid swelling, the 21-30 age group had a 27% prevalence, predominantly affecting females. Most cases were non-neoplastic, with Colloid Goitre being the most common. Neoplastic cases were mostly dominant within the 21-40 age group. Bethesda's classification revealed a benign nature, thus being categorised as Category 2 (benign). All patients had neck swelling, along with other symptoms. Cytological-histopathological concordance occurred in 68/70 cases, highlighting the importance of a comprehensive diagnostic approach. The study provides valuable insights into the demographic characteristics, prevalence, and distribution of thyroid lesions, guiding clinical understanding and public health planning. The dominance of non-neoplastic lesions, particularly Colloid Goitre, underscores the need for accurate diagnostic methods. The cytological-histopathological concordance supports the reliability of cytological diagnoses, reinforcing the significance of combined assessments for optimal patient care.

Discussion

The age spectrum of patients with thyroid lesions in this study ranged widely from 10 to 77 years, demonstrating an average age of 32.76 years. Notably, a substantial proportion (46%) of thyroid lesions were within the 21-40 age group, underscoring a demographic predilection. Comparative insights from V. Jain *et al.* [9] emphasised a similar trend, with a focal point in the 31-40 age bracket, where the average age of the population was 41.3 ± 12.4 years. In contrast, T. Thakor *et al.* [15] determined the predominance in the 41-50 age group, with an average age of 39.64 years.

The gender dynamics within the present study group demonstrated female predominance, constituting 84% of cases compared to males at 16%. This trend aligns with previous research by D.S. Bhadouria *et al.* [16], confirming a prevalence of thyroid lesions among females. The urban-rural distribution disclosed a distinct inclination toward urban areas in the present study, with a ratio of 3.45:1. This urban dominance echoes the findings reported by D. Asmelash *et al.* [17]. Moreover, female dominance remained a consistent pattern, with 88% females and 12% males, illustrating a striking female-to-male ratio of 7.3:1. This gender disproportionality resonates with the findings of earlier studies by V. Jain *et al.* [9] and T. Thakor *et al.* [15], as well as the study conducted by C.B. Patel *et al.* [18], which reported a male-to-female ratio of 1:4.8. Observed ratios in the present study are in concordance with those reported by T. Thakor *et al.* [15] and V. Jain *et al.* [9], highlighting the recurrent theme of thyroid lesions exhibiting a higher prevalence among females.

In the context of the present study, a substantial majority, accounting for 95% of the cases, exhibited non-neoplastic thyroid lesions, contrasting with 5% of cases characterised as neoplastic. These proportions align closely with findings from S. Ranabhat *et al.* [19], who reported an 88%

prevalence of non-neoplastic lesions and a 12% incidence of neoplastic lesions. This consistent pattern is also reflected in the investigation by V. Jain *et al.* [9], where non-neoplastic lesions were more prevalent. The symptomatic presentation within the present study unveiled neck swelling as the most prevalent complaint, constituting a chief concern in all cases. Further analysis disclosed a nodular manifestation in 64% of cases, while 36% exhibited diffuse swelling. Accompanying symptoms included weight gain in 4% of cases, cold intolerance in 3%, and weight loss in 3%. Additional complaints, such as anxiety, palpitation, and fever, were less frequent, reported by 1% and 2% of patients, respectively. Exophthalmos was observed in 9% of cases, while dysphagia and a change in voice were reported by 4% and 5% of patients, respectively. This corroborates the consistent emphasis on neck swelling as the primary patient-reported symptom in studies by V. Jain *et al.* [9] and M.N. Haque *et al.* [20].

Bethesda system for cytological classification revealed a substantial predominance of cases within the benign spectrum, specifically categorised as Category 2, constituting 95% of the cases. Interestingly, only 2 cases were designated as Category 4 (FN/SFN), and 3 cases were classified under Category 6 (malignant). Remarkably, the present study did not encounter any cases falling within Category 1, 3, or 5. This distribution aligns with the observations of V. Jain *et al.* [9], who noted a similar prevalence of lesions in Category 2 (69.1%) within the Bethesda System. A corroborating study by M. Syed *et al.* [21] demonstrated the majority of their patients also belonging to Category 2, with a prevalence of 33.3%. These consistent findings underscore the robustness and reliability of the Bethesda system categorization across diverse studies. Exploring the spectrum of thyroid lesions, the present study uncovered a notable prevalence of non-neoplastic cases, with Colloid Goitre emerging as the predominant lesion, constituting 72% of the total non-neoplastic cases. Hashimoto Thyroiditis and Lymphocytic Thyroiditis followed, contributing 16% and 3%, respectively, to the non-neoplastic category. In the neoplastic lesions, both Papillary Carcinoma and Follicular Neoplasm were observed in 2% of each of the cases. Comparable patterns were identified in the study conducted by V. Jain *et al.* [9], wherein Colloid Goitre predominated among non-neoplastic lesions, accounting for 40.6% of the cases. In their evaluation of neoplastic lesions, Follicular Neoplasm took precedence, reflecting a consistency of findings across studies. C.B. Patel *et al.* [18] further supported these observations, reporting Colloid Goitre as the prevalent lesion in the majority of their cases (65.1%). These collective findings underscore the recurring prominence of specific thyroid lesions, providing valuable insights into the relative distribution of these lesions across different studies.

Histopathological confirmation was available for 70 cases in the present study, shedding light on the concordance between cytological and histological assessments. Among the non-neoplastic cases, 60 out of 61 cases initially diagnosed as Colloid Goitre cytologically were corroborated as Colloid Goitre upon histological examination. However, a singular case initially identified as Nodular Goitre cytologically was histopathologically determined to be Papillary Carcinoma, highlighting the challenges in accurately diagnosing Papillary Carcinoma, especially in the presence of cysts or co-existing with nodular colloid goitre without cystic changes. These diagnostic intricacies align with the observations made by M.N. Haque *et al.* [20], who reported Multinodular Goitre as the predominant non-neoplastic lesion in 55.76% of their cases, followed by Papillary Thyroid Carcinoma at 25%. D.S. Bhadouria *et al.* [16] also emphasised the prevalence of Multinodular Goiter (MNG) in the majority of their cases (55%), supporting the diverse distribution of thyroid lesions. The need for a meticulous examination of nuclear features, particularly in longstanding goitre cases, becomes imperative to ensure accurate and timely diagnosis, thereby guiding appropriate clinical management. In evaluating the diagnostic performance of FNAC in the present study, a sensitivity of 80%, specificity of 98.46%, positive predictive value (PPV) of 80%, negative predictive value (NPV) of 98.46%, and an overall diagnostic accuracy of 97.14% was recorded. These values affirm the effectiveness of FNAC in diagnosing thyroid lesions, providing reliable results. Comparable studies conducted by A. Jamaiyar & K. Yogesh [7] reported a sensitivity of 90.91% and specificity of 94.12%, further reinforcing the robustness of FNAC in accurately identifying thyroid abnormalities. M. Syed *et al.* [21] demonstrated sensitivity and specificity of 82.3% and 64.3%, respectively, along with PPV and NPV of 73.6% and 75%. Despite differences in specificity, these findings align with the present study's observations and underscore the consistent utility of FNAC across diverse studies. Additionally, prior investigations by various researchers [22, 23] reported sensitivity, specificity, and diagnostic accuracy ranging from 85.7% to 98.6%, 72.5% to 97.7%, and 83.5% to 92.2%, respectively. This collective evidence highlights the reliability and reproducibility of FNAC as a valuable diagnostic modality in the assessment of thyroid lesions, emphasizing its significance in clinical practice.

In alignment with the established guidelines of the American Thyroid Association (ATA), the present study not only delved into cytological assessments but also considered the crucial aspect of thyroid hormone status, particularly focusing on serum TSH levels as an integral component of the initial evaluation for thyroid lesions. The diverse aetiology of thyroid lesions contributes to variations in thyroid hormone statuses, a factor contingent upon the disease's stage and extent. Within the present study group, a majority of patients exhibited a euthyroid state (76%). Analysing the relationship between thyroid disease and hormonal status, a significant proportion of individuals with colloid goitre (83.33%) maintained euthyroid status. This was consistent with the findings of S. Ranabhat *et al.* [19]. Additionally, V. Jain *et al.* [9] reported a predominant euthyroid status in their patient population (69.1%), followed

by hypothyroid (18.8%) and hyperthyroid (12.1%) cases. These observations underscore the intricate interplay between thyroid lesions and hormonal equilibrium.

Goitre, characterised by the enlargement of the thyroid gland, often arises from impaired thyroid hormone synthesis, frequently attributed to dietary iodine deficiency. This deficiency triggers an elevation in TSH levels, prompting compensatory hypertrophy and hyperplasia of thyroid follicular cells, ultimately culminating in glandular enlargement. The consequential goitre causes elevated hormonal levels, resulting in the attainment of euthyroid status among affected patients [24]. The present study further substantiates these insights, emphasizing the intricate relationship between iodine deficiency, TSH elevation, and subsequent thyroid gland alterations. In the context of specific thyroid disorders, the present study's findings align with previous studies. In patients with Hashimoto's thyroiditis, a substantial majority (62.5%) exhibited hypothyroidism, underscoring the impact of autoimmune inflammation on thyroid function. Conversely, among cases of lymphocytic thyroiditis, 66.67% maintained euthyroid status, consistent with the expected resolution of thyroid dysfunction post-inflammation subsidence within six to eight weeks [24]. Cytologically, the present study's observations revealed distinctive features in Hashimoto's or lymphocytic thyroiditis, including thyroid follicular cells intricately entwined with lymphocytes, oxyphil cells, a polymorphous population of lymphocytes, multinucleated giant cells, and scant or absent colloid. Furthermore, the present study reinforces the correlation between cytological findings and thyroid function in neoplastic cases. All instances of follicular neoplasm, papillary carcinoma, and medullary carcinoma were associated with euthyroid status, aligning with similar trends observed in prior studies [19]. This defines FNAC as a valuable tool for early and accurate diagnosis, particularly when complemented by clinical assessments and thyroid function tests. This integrated diagnostic approach significantly reduces the necessity for surgical interventions, offering a comprehensive strategy for the effective management of diverse thyroid lesions [9, 18, 25]. The recognition of such correlations provides clinicians with essential insights, facilitating optimal decision-making in the management of thyroid disorders.

Conclusions

Examination and analysis of thyroid abnormalities via cytological assessment and their association with TFT outcomes highlighted the significant utility of FNAC. When integrated with TFT results, FNAC is a powerful tool for guiding the treatment of individuals with thyroid irregularities, given its remarkable precision, sensitivity, and specificity. The recent study involving 100 cases of thyroid swelling yielded valuable insights into the demographics and characteristics of thyroid lesions. With an average patient age of 32.76 years, the highest incidence of thyroid lesions occurred in the 21-30 age group (27%), predominantly affecting females (88%). Non-neoplastic cases outweighed neoplastic ones (95% vs. 5%), with Colloid Goitre emerging as the most prevalent lesion (72%). Neoplastic cases were concentrated in the 21-40 age group (60%). Bethesda classification indicated a predominantly benign nature, with Category 2 (benign) accounting for 95% of cases. A sensitivity of 80%, specificity of 98.46%, PPV of 80%, NPV of 98.46%, and an overall diagnostic accuracy of 97.14% was recorded. The study highlights the practical significance of these findings in guiding clinical decisions, especially with the prominence of Colloid Goitre and the high reliability of cytological diagnoses. Numerical indicators, such as demographic percentages and lesion prevalences, provide a clear quantitative overview of the study outcomes. Further research should include exploring molecular aspects of prevalent thyroid lesions, conducting longitudinal studies, and investigating targeted therapeutic approaches based on specific lesion types.

Acknowledgements

The authors express their sincere gratitude to all individuals and their institutions who contributed to the completion of this manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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Цитологічне дослідження різних уражень щитовидної залози та його взаємозв'язок з оцінкою функції щитовидної залози

Ручі Ядав

Бакалавр медицини, бакалавр хірургії, молодший резидент
Медичний коледж Баба Рагхава Даса
273013, м. Горакхпур, штат Уттар Прадеш, Індія
https://orcid.org/0009-0006-1899-0120

Шайла Мітра

Доктор медицини, професор
Медичний коледж Баба Рагхава Даса
273013, м. Горакхпур, штат Уттар Прадеш, Індія
https://orcid.org/0009-0007-4719-9714

Раджеш Рай

Доктор медицини, професор
Медичний коледж Баба Рагхава Даса
273013, м. Горакхпур, штат Уттар Прадеш, Індія
https://orcid.org/0009-0009-5017-7502

Анотація. Вивчення комбінованого використання тонкоголкової аспіраційної цитології, сонографії та функціональних тестів щитовидної залози має вирішальне значення для точної діагностики збільшення щитовидної залози як у дорослих, так і у дітей. Дана робота була спрямована на вивчення уражень щитовидної залози за допомогою цитологічного аналізу та їх кореляції з результатами тестів функції щитовидної залози. У цьому перехресному дослідженні взяли участь 100 пацієнтів із підозрою на захворювання щитоподібної залози та утворення вузлів. Комплексна оцінка включала демографічні показники клініки, процедури тонкоголкової аспіраційної цитології та профілі гормонів щитовидної залози. На основі системи Bethesda, цитологічні діагнози корелювали з результатами аналізів функції щитоподібної залози методом хемілюмінесцентного імуноферментного аналізу з мікрочастинками. Було встановлено, що найбільш поширеними виявилися непухлинні ураження щитовидної залози (95 %), причому найчастіше зустрічався колоїдний зоб. Неопластичні випадки в основному включали папілярну та фолікулярну карциному. Більшість уражень щитоподібної залози спостерігалися у віковій групі 21-30 років, непухлинні ураження частіше зустрічалися у віці 10-20 років, а неопластичні – у віці 21-40 років. У всіх пацієнтів спостерігалося збільшення щитоподібної залози. Більшість випадків були еутироїдними (76 %), переважно належали до категорії 2. Була відмічена сильна кореляція між цитологічними діагнозами та рівнем тиреоїдних гормонів (p=0,04). Тонкоголкова аспіраційна біопсія показала високу чутливість (80 %) та специфічність (98,46 %), з позитивною прогностичною цінністю 80 % та негативною прогностичною цінністю 98,46 %, що призвело до діагностичної точності 97,14 %. Дослідження підкреслює важливу роль тонкоголкової аспіраційної біопсії у поєднанні з оцінкою функції щитоподібної залози для ефективного ведення пацієнтів з ураженнями щитоподібної залози завдяки її високій точності, чутливості та специфічності

Ключові слова: тонкоголкова аспіраційна цитологія; система Bethesda; щитовидна залоза; цитологія; гістопатологія