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ORIGINAL RESEARCH

Sonographic evaluation of thyroid lesions with FNAC correlation

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Abstract
Introduction: Thyroid disorders are common in Indian adult population. Current management guidelines from the American Thyroid Association (ATA) recommend diagnostic ultrasonography for all patients with thyroid nodules. However, suspicious and few overlapping characteristics of benign and malignant thyroid nodules makes FNAC unquestionable. Unwanted suspicion leads to excessive unnecessary biopsies and insufficient lower suspicion leads to under-diagnosis or missing of thyroid malignancies. Hence, making accurate decision of whether a nodule is potentially malignant or not is crucial.
Aims and objectives: To study the USG features of thyroid lesions in patients with thyroid disorders and correlate these USG findings with FNAC in the diagnosis of thyroid lesions.
Methods: The cross-sectional study was done for 18 months among patients of thyroid disorders coming to the Radio-diagnosis department of Muzaffarnagar Medical College for routine USG scan for thyroid lesions. A sample of 50 patients was taken among the age group of 10-75years who gave consent for FNAC and did not have any bleeding disorders. Sonographic evaluation of the thyroid gland was done by characterising its size, shape, echogenicity, vascularity and presence or absence of nodules. The respective nodules were assed for suspicious patterns and FNAC of the nodules was done to correlate the radiological with pathological diagnosis.
Results: As per the study, with good sensitivity and specificity, radiological examination of thyroid lesions by USG showed significant correlation with pathological evaluation of thyroid lesions by FNAC examination. A strong positive correlation between the two diagnostic procedures was seen. The correlation was statistically significant, with a $P < 0.05$.
Conclusion: Thyroid gland ultrasound is a non-invasive, cost-effective and patient compliant technique in assessing and diagnosing thyroid swellings which can be performed as the initial investigation before FNAC examination for quickly assessing thyroid nodules, their vascularity and identifying benign from malignant lesions.This would avoid unnecessary invasion and its related complications like puncturing an highly vascular nodule which could be determined on USG itself.
Keywords: Thyroid; USG; FNAC; Benign; Malignant; Suspicious; Invasive; Radiological; Pathological

Introduction

The thyroid gland, distinct due to its early fetal development and size, plays a crucial role in regulating metabolic functions such as heart rate, skeletal growth, and lipid metabolism.[1]Thyroid lesions are relatively common worldwide and can range from developmental and inflammatory to hyperplastic and malignant conditions.[2] Thyroid abnormalities, which include systemic conditions like Graves' disease and localized expressions like goitres, are more prevalent in women, with an incidence rate four times higher than in men. [3] Although 90% of thyroid nodules are benign, the risk of malignancy in solitary nodules ranges from 10% to 30%.[4]
High-resolution ultrasonography (USG) has become the preferred imaging technique for thyroid evaluation due to its ability to clearly display normal anatomy, anatomical variations, and pathological conditions.[5] It is particularly effective in detecting even small, non-palpable lesions. USG is often combined with other diagnostic methods like

fine-needle aspiration cytology (FNAC), thyroid function tests (TFT), and histological analysis for comprehensive assessment, as these methods alone may be insufficient.[6,7]

While USG is fast, non-invasiveand economical, it has limitations, such as its inability to assess ectopic thyroid tissue or determine the functional state of a nodule. Colour Doppler studies have enhanced diagnostic accuracy by providing additional information on lesion morphology and vascularity.[8-10] However, the definitive diagnosis often requires FNAC, particularly for potentially malignant nodules.[11-14]

The current study aims to evaluate the effectiveness of USG and FNAC in differentiating benign from malignant thyroid nodules. The research is conducted in a tertiary care facility located in the Himalayan goitrebelt of northern India, where thyroid lesions and malignancies are endemic. Despite the high prevalence of thyroid conditions in this region, there is a lack of prospective studies, making this research significant for improving local clinical practice.

Methodology

Study Design: This is a cross-sectional study conducted over eighteen months, with twelve months dedicated to data collection and six months for data analysis.

Study Setting: The research was carried out in the Radio-diagnosis and Pathology outpatient departments of Muzaffarnagar Medical College and Hospital, Muzaffarnagar, Uttar Pradesh, India.

Sample Selection

A total of 50 patients, presenting with thyroid disorders and lesions identified via ultrasonography (USG), were included in the study. The sample size was determined based on the number of similar cases evaluated in the department over the last three years.The inclusion criteria for the study involved patients who provided informed consent, individuals aged between 10 and 75 years, and those diagnosed with thyroid lesions through ultrasonography (USG). Exclusion criteria included patients who refused to provide consent for fine-needle aspiration cytology (FNAC) and those with a history of acute or chronic bleeding disorders.

Study Procedure

Each patient provided written informed consent and a detailed clinical history before undergoing evaluation. The thyroid gland was examined using USG to assess its size, echogenicity, vascularity, and the presence or absence of nodules. Identified nodules were classified as either suspicious (potentially malignant) or non-suspicious (potentially benign) under expert supervision.Following USG, FNAC was performed on the identified lesions to correlate ultrasound findings with cytological results, ensuring accurate diagnosis.USG examinations were conducted using 2D grayscale and color Doppler modes with linear array transducers (7.5–12 MHz) on SAMSUNG HS60 and

Alpinion Ecube 8 machines.

Examination Technique

Patients were positioned supine with their necks hyperextended. The thyroid gland was examined in sagittal, transverse, and oblique planes, focusing on the isthmus, both the lobes,internal jugular veins, and carotid arteries, . Lymphadenopathy in the surrounding regions was also assessed.

Neck Palpation: The neck was palpated to estimate nodule size and position.

Scanning: Transverse and longitudinal scans were performed to visualize the thyroid gland and differentiate between intra- and extrathyroidal lesions.

FNAC Procedure

The target area was cleaned with povidone-iodine, and the neck was hyperextended before FNAC. A standard 1½" 25 gauge needle with a 10 ml syringe was used to aspirate the nodule under USG guidance. The aspirate was spread on slides, fixed in alcohol, and sent to the pathology department for examination.

Data Analysis

The data were analyzed to evaluate the effectiveness of USG and FNAC in distinguishing between benign and malignant thyroid lesions. The correlation between USG and FNAC results was used to determine the diagnostic accuracy in the study population.Analysis was done using IBM SPSS (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 25 for Windows software program. Chi-square test was used along with level of significance was set at $P \leq 0.05$, power of study was set at 80% while confidence interval was set at 95%.

Result

The study's findings provide important insights into the correlation between gland size, echotexture, vascularity on ultrasonography (USG), and fine-needle aspiration cytology (FNAC) results in patients with thyroid lesions. These correlations are crucial in understanding the diagnostic value of USG and determining the potential for malignancy in thyroid nodules, which could guide clinical decision-making.The demographic analysis showed that the majority of participants were aged 30-40 years (42%), followed by 20-30 years (26%). Females dominated the study, comprising 94% of the sample, reflecting the higher prevalence of thyroid disorders in women. Additionally, 26% of participants had a positive family history of thyroid disorders, suggesting a potential genetic influence. (Table 1)

The majority of patients in this study (84%) presented with an enlarged thyroid gland. Among these, 88.1% were diagnosed as benign on FNAC, while 11.9% were found to be malignant. This finding indicates that while an enlarged gland is often associated with benign conditions, a significant minority of these cases can still be malignant. The study also found that 14% of patients had a normal-sized gland, with a similar benign-to-malignant ratio (85.7% benign and 14.3% malignant). Only 2% of patients had a reduced gland size, and all of these cases were benign. The p-value for gland size correlation with malignancy was 0.91, suggesting that gland size alone is not a statistically significant predictor of malignancy. This emphasizes that while an enlarged gland may raise clinical suspicion, it should not be relied upon solely to determine the risk of cancer. (Table2)

Echotexture is another key factor assessed during USG, with the majority of glands in this study (86%) showing a heterogeneous echotexture. Of these, 88% were benign and 12% were malignant based on FNAC results. This indicates that while heterogeneous echotexture is often associated with benign lesions, a significant number of these cases may still harbor malignancies. Notably, all cases with a homogeneously hypoechoic or hypoechoic echotexture were benign, which suggests that these echotexture patterns might be indicative of non-malignant conditions. On the other hand, the single case with a homogenous echotexture was malignant, highlighting that homogenous echotexture, though rare, should not be disregarded in the assessment of thyroid nodules. The lack of significant p-values for echotexture categories reinforces the conclusion that echotexture alone is insufficient to definitively diagnose malignancy. (Table 2)

Vascularity, as assessed by Doppler ultrasound, also plays a crucial role in the evaluation of thyroid lesions. In this study, 44% of the glands had increased vascularity, with 77.3% of these cases being benign and 22.7% malignant. This suggests that while increased vascularity is commonly seen in benign conditions, it can also be associated with malignancy, making it an important factor to consider in the diagnostic process. Conversely, decreased vascularity was observed in 16% of the cases, all of which were benign. This finding may indicate that decreased vascularity could be more indicative of non-malignant lesions. Normal vascularity was present in 40% of the cases, with the vast majority being benign (95%) and a small percentage malignant (5%). The p-value for vascularity correlation was 0.11, indicating that while vascularity is an important diagnostic feature, it alone is not sufficient to predict malignancy with high accuracy.

The study underscores the complexity of diagnosing thyroid malignancies using USG alone. Although gland size, echotexture, and vascularity provide valuable information, none of these features, when considered independently, are definitive predictors of malignancy. This highlights the importance of using FNAC in conjunction with USG to improve diagnostic accuracy. FNAC provides a cytological evaluation that is crucial for confirming malignancy, especially in cases where USG findings are ambiguous or show overlapping features between benign and malignant conditions. (Table 3)

Table 1: Demographic Characteristics of the Study Population

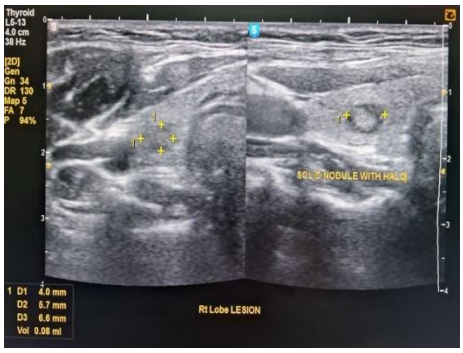
Variable	Category	Frequency	Percent
Age Group	<20	1	2.0%
	20-30	13	26.0%
	30-40	21	42.0%
	40-50	11	22.0%
	>50	3	6.0%
Gender	Male (M)	3	6.0%
	Female (F)	47	94.0%
Family History	Positive	13	26.0%
	Negative	37	74.0%
Total		50	100.0%

Table2: Correlation of Gland Size, Echotexture, and Vascularity with FNAC Results

Variable	Category	Total	Percent	Benign (FNAC)	Percent	Malignant (FNAC)	Percent
Size of Gland	Enlarged	42	84.0%	37	88.1%	5	11.9%
	Normal	7	14.0%	6	85.7%	1	14.3%
	Reduced	1	2.0%	1	100%	0	0%
	Total	50	100%	44	88%	6	12%
	P-value		0.91				
Echotexture	Heterogeneous	43	86.0%	38	88%	5	12%
	Heterogeneously Hypoechoic	3	6.0%	3	100%	0	0%
	Homogeneously Hyperechoic	1	2.0%	1	100%	0	0%
	Homogeneous	1	2.0%	0	0%	1	100%
	Hypoechoic	2	4.0%	2	100%	0	0%
	Total	50	100%	44	88%	6	12%
	P-value		0.91				
Vascularity	Decreased	8	16.0%	8	100%	0	0%
	Increased	22	44.0%	17	77.3%	5	22.7%
	Normal	20	40.0%	19	95%	1	5%
	Total	50	100%	44	88%	6	12%
	P-value		0.11				

Table 3:Comparison between USG diagnosis and FNAC correlation.

Disease	USG	FNAC	Sensitivity of USG
Colloid goiter	12	11	91.6%
Multinodular goiter	12	11	91.6%
Hyperplastic goiter	6	5	83%
Thyroiditis	13	16	81%
Neoplastic etilogy	6	5	83%
Others	1	2	-
Total	50	50	-



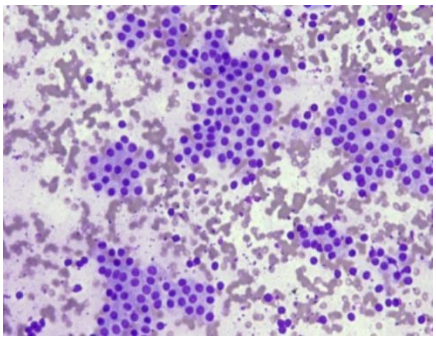


Figure1: Colloid goitre:29-year-old female with hyperthyroidism. On USG,heterogenous gland with hyper echoic nodules with peripheral halo and mild peripheral vascularity.Thyroid FNAC shows sheets of benign follicular cells with abundant colloid suggestive of colloid goitre.

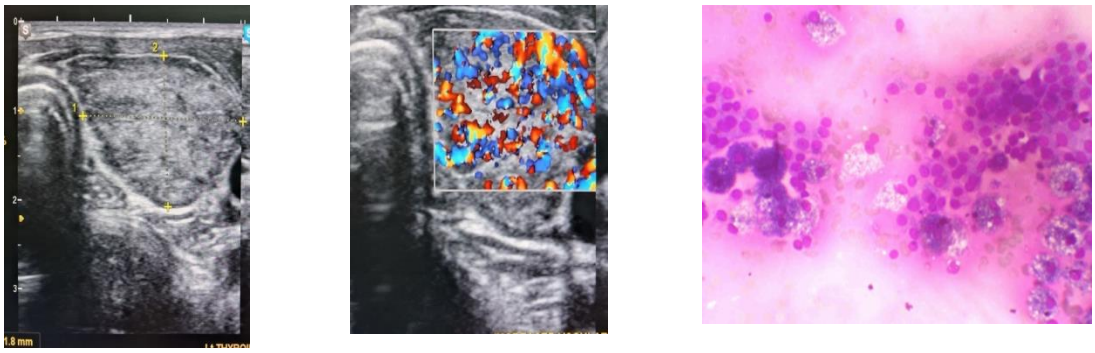


Figure 2:Multi nodular goitre:40-year-old female with swelling in midline of neck. On USG, B/L lobes of thyroid had multiple, <5mm in size, smooth marginated, heterogeneously hypoechoic nodules.The gland showed diffusely increased vascularity on colour doppler study.Thyroid FNAC of the gland shows follicular epithelial cells with foamy macrophages on the background of diffuse goitre.

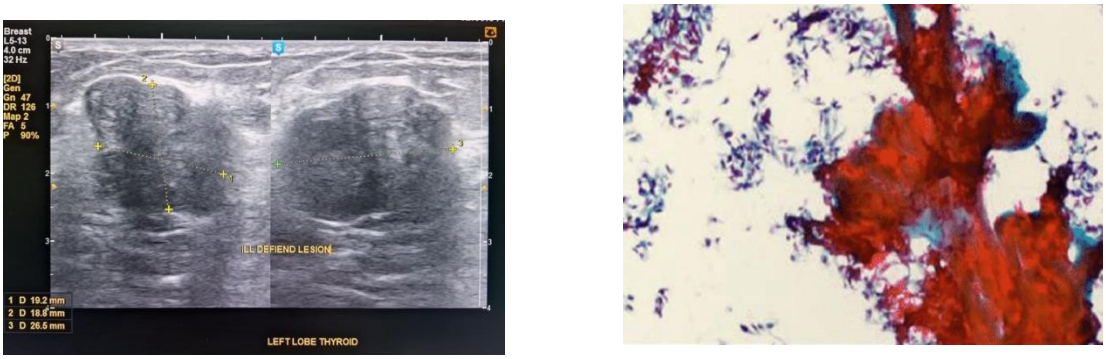


Figure 3:Papillary carcinoma of thyroid:A37-year-old female with palpable neck swelling. On USG, a heterogeneously hypo echoic, ill defined, lobulated lesion with micro-calcifications and intense vascularity on colour Doppler is seen in left lobe of thyroid. Thyroid FNAC of the lesion showed hyper-cellular neoplastic cells in papillary form arranged as sheets with nuclear pseudoinclusions.

Discussion

Ultrasonography (USG) of the thyroid gland is a non-invasive, patient-friendly, and cost-effective diagnostic tool for evaluating thyroid swellings. A 12 MHz transducer is often utilized for high-resolution imaging. However, due to its higher diagnostic reliability, fine-needle aspiration cytology (FNAC) is generally considered the initial investigation of choice, as recommended by the American Thyroid Association (ATA) and the National Comprehensive Cancer Network.[15] Despite the utility of USG in assessing thyroid nodules and differentiating benign from malignant lesions, the significant overlap in the sonographic appearance of these nodules necessitates USG-guided FNAC for definitive diagnosis. Accurate assessment of a nodule's malignancy potential is crucial, as insufficient suspicion can lead to missed thyroid cancers, while excessive suspicion may result in unnecessary biopsies.[16]

In this study, the age distribution showed that 26% of cases were in the 20-30 years age group, 42% were in the 30-40 years age group, and 30% were over 40 years. The mean age was 36.94 years. This contrasts with other studies, such as Singh P et al. (2000)[15], where the mean age was 47 years, and Islam et al. (2009), which found most patients between 21 and 40 years.[17]Rangaswamy M, et al. examined 585 patients with a mean age of 40.57 years and an age range of 11 to 70 years. [18]Gender distribution was predominantly female, with 94% of participants being women, reflecting a common trend in thyroid disorders, likely due to the abundance of estrogen receptors in the thyroid gland. Clinical presentation in this study included swelling in 80% of cases, pain in 30%, and fever in 12%. Comparatively, Prakash A et al.[19] reported goiter in 95.55% of cases, while Godinho-Matos L. et al.[20] found goiter in 100% of cases, with lower incidences of dysphagia, dyspnea, and hoarseness of voice. The thyroid status in this study revealed 18% euthyroid, 54% hyperthyroid, and 28% hypothyroid cases, differing from Godinho-Matos L. et al.'s[20] findings, where euthyroid status was predominant.

Regarding the types of thyroid lesions, this study found multinodular goiter, colloid goiter, thyroiditis, hyperplastic goiter, and neoplastic cases at 24%, 24%, 18%, 12%, and 10%, respectively. Bumiya and Roopa reported a higher prevalence of benign goiter cases at 90%, with 66% being goiter cases.[21] USG was able to detect 90% benign and 10% malignant nodules, similar to findings by Dhanadia A et al., who found 66% benign and 34% malignant lesions.[22]The correlation between USG and FNAC in this study was 99%, indicating significant accuracy, although USG alone was less effective in consistently differentiating inflammatory lesions.

When combined with FNAC, USG showed 100% sensitivity, 93.75% specificity, 40% positive predictive value (PPV), 100% negative predictive value (NPV), and 94% accuracy. These results are comparable to other studies, such as those by Watters DA et al. [23], Cai XJ et al. [24], and Jones AJ et al.[25] , which reported varying degrees of sensitivity and specificity. However, the relatively low PPV in this study, at 40%, contrasts with higher PPV values found in most other studies. The gold standard for diagnosing thyroid malignancy remains FNAC, with the Bethesda reporting system showing high sensitivity, specificity, NPV, and PPV, though FNAC has been noted to have a 15% false-negative rate

Conclusion

The study highlights the utility of ultrasonography (USG) in conjunction with fine-needle aspiration cytology (FNAC) for the evaluation of thyroid nodules. While USG is a valuable non-invasive tool for the initial assessment, it alone is insufficient to definitively distinguish between benign and malignant thyroid lesions due to significant overlap in the sonographic characteristics. The study found that an enlarged thyroid gland, heterogeneous echotexture, and increased vascularity are frequently associated with benign conditions, but these features can also be present in malignant cases, underscoring the need for FNAC to confirm malignancy.The correlation between USG findings and FNAC results in this study was high, with a 99% agreement, demonstrating the accuracy of these combined diagnostic methods. However, the study also revealed that USG alone has limitations, particularly in identifying inflammatory lesions and predicting malignancy with high specificity.The results reinforce the importance of a comprehensive diagnostic approach, combining USG and FNAC, to accurately assess and manage thyroid nodules, reducing the risk of missed malignancies and unnecessary biopsies.

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