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Original Research Article

Correlate Gray Scale and Color Doppler Ultrasonographic Findings of Thyroid Nodules with FNAC

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Abstract:

Background: Thyroid nodules are characterized by discrete lesions that are radiologically different from the surrounding thyroid tissue. They could be inadvertently seen on high resolution ultrasonography or clinically perceptible. Despite the fact that thyroid nodules are relatively common in the general population, most of them are benign. Although fine needle aspiration cytology is the gold standard for making the final diagnosis and allows for a true differentiation between benign and malignant nodules, high resolution ultrasonography plays a significant role in identifying the characteristics and quantity of lesions.

Methods: From May 2022 to April 2023, the Department of Radiodiagnosis at Sri Krishna Medical College and Hospital in Muzaffarpur, Bihar, conducted this hospital-based observational study. After getting written consent, fifty patients in all presented with thyroid enlargement or a palpable nodule with or without symptoms. Each patient had FNAC utilizing a 23G needle after high resolution ultrasonography using a 7–12MHz linear transducer. The outcomes were statistically evaluated with the right tools and procedures.

Results: Most of the patients in our study were female and ranged in age from 30 to 60 years. Due to an inadequate sample size, FNAC failed to provide the final diagnosis in 4/50 cases. With USG, the identification of benign and malignant conditions was rather precise. While the majority of malignant nodules were hypoechoic on USG, the majority of adenomas were hyperechoic. Hypoechogenicity, microcalcification, invasion of the strap muscles, cervical adenopathy, and intralesional vascularity were indicative of malignancy. Thyroiditis and adenoma were the conditions that USG detected with the greatest accuracy, followed by colloid nodules, and malignant nodules with the least accuracy.

Conclusion: It is possible to accurately distinguish between benign and malignant lesions using gray scale ultrasonography in conjunction with color Doppler imaging, as well as to identify thyroiditis or toxic goitre adenoma lesions. It aids in evaluating whether a nodule is solid or cystic. The USG clearly shows the amount of lesions. FNAC can be used to offer the tissue diagnosis in challenging circumstances.

Keywords: Ultrasonography, Fine Needle Aspiration Cytology, Thyroid Nodules.

Introduction

The incidence of thyroid nodules depends heavily on the procedure used for diagnosis. The estimated prevalence by palpation alone ranges from 4% to 7%[1,2], whereas US finds nodules in 20% to 76% of the adult population[3,4], particularly with the use of high-resolution US techniques currently available.[5] With ranges between 50% and 65%, the reported frequencies discovered by the US are consistent with the prevalence recorded after surgery and autopsies.[6]

In the general population, thyroid nodules are present in between 3% and 8% of cases. With the exception of some endemic places like the "Himalayan goiter belt," the profile of thyroid problems experienced by people in India across all age groups is comparable to that seen in the majority of other countries. In the form of an enlarged thyroid mass or thyroid nodule, other pathological abnormalities, such as thyroid neoplasms, are also present. Thyroid enlargement may be a symptom of numerous immunological thyroid illnesses, such as hypo- and hyperthyroid conditions.

After a clinical evaluation, HRUSG is frequently used as the initial imaging technique. The use of CT and MRI imaging can then be more carefully considered. Fine needle aspiration cytology (FNAC) is a recognized, first-line screening method that is quick, easy, and can be used to diagnose both surgical and non-surgical goitres.

The main FNAC limitations are insufficient sampling and overlapped cytological characteristics.

Micro calcifications, significant hypoechogenecity, uneven or microlobulated borders, and intranodular core vascularity are sonographic characteristics of potentially cancerous thyroid nodules.[1] In addition to making it easier to diagnose nodules that are clinically obvious, widespread use of ultrasonography has revealed a large number of nodules in the thyroid gland that are clinically undetectable and distinguished the majority of them as benign from malignant nodules.

However, the malignant thyroid nodules are rare. The majority of malignant thyroid nodules grow slowly and may be minor when they are first found.

Nodules are less common in aggressive thyroid carcinoma, which can be big, stationary, or even rapidly expanding.

The majority of the time, thyroid nodules is benign and unproblematic. However, it is crucial to take notice if any unusual neck swelling develops, particularly if breathing or swallowing issues develop. It is crucial to be aware of the danger of developing cancer.

Material and Methods

This prospective hospital-based observational study was conducted from May 2022 to April 2023 at the Department of Radiodiagnosis at Sri Krishna Medical College and Hospital in Muzaffarpur, Bihar. A total of fifty individuals were included who had non-palpable thyroid lesions found by high resolution USG as well as palpable thyroid enlargement with or without any symptoms.

FNAC was performed using a 23-gauge needle connected to a 10-cc disposable syringe, while real-time grey scale USG and color Doppler studies were performed using high frequency linear probes operating at 7–12 MHz.

With the patient's neck extended and in the supine position, an ultrasonic neck examination was carried out utilizing a high frequency linear probe. The aspirated material from the swelling was divided into two smears, the first of which was air dried and stained with MGG and the second of which was fixed wet in ether and stained with H&E.

Different grey scale and Doppler data were examined for their sensitivity, specificity, positive predictive value, negative predictive value, and clinical importance. In all circumstances, FNAC correlation is used as the benchmark.

Results

In our study, there were 42 more female participants than male, or 8 to 1. The majority of the 32 patients (64%) were in the 31–60 age range, followed by 10 patients (20%) in the 61–plus age range and 8 individuals (16%) in the 0–30 age range.

The majority of the study participants exhibited noticeable, significant swellings around their thyroids. Other signs of thyroid disease included 6% of tremors, 8% of swallowing difficulties, 8% of weight increase and 6% of weight loss, and 2% of voice changes.

On USG, 9 (18%) patients had adenoma, 11 (22%) had thyroiditis, 19 (38%) had a colloid goitre, and the remaining 11 (22%) had carcinoma [Table 1].

Table 1: Provisional Diagnosis Using Ultrasonography and Color Doppler

Classification	No. of cases	Percentage
Colloid goiter	19	38.0%
Adenoma	9	18.0%
Thyroiditis	11	22.0%
Carcinoma	11	22.0%
Total	50	100.0%

According to histopathology, 17 (34%) of the patients had colloid goiters, compared to 9 (18%) who had adenomas, 10 (20%) who had cancers, 10 (20%) who had thyroiditis, and 4 (8%), who had just RBCs [Table 2].

Table 2: Provisional Diagnosis Using Histopathology

Classification	No. of cases	Percentage
Colloid goiter	17	34.0%
Adenoma	9	18.0%
Thyroiditis	10	20.0%
Carcinoma	10	20.0%
RBC’s only	4	8.0%
Total	50	100.0%

Distribution of cases based on echogenicity on USG and final diagnosis. [Table 3].

Table 3: Echo Texture Ultrasound

Echo texture	Adenoma	Colloid goiter	Thyroiditis	Malignant/carcinoma
Hyper	6	0	1	0
ISO	3	0	0	0
Hypo	0	1	3	11
HETRO	0	0	7	0
Aneehoic	0	18	0	0
Total	9	19	11	11

Table 4: Distribution of cases based on Doppler findings

Classification	No. of cases	Percentage
Type 1 Normal	19	38.0%
Type 2 Peri/Spoke wheel	9	18.0%
Type 3 Intra lesional/+	11	22.0%
Type 4 Diffuse increase	11	22.0%

Table 5: Characteristic of malignant nodules on Ultrasonography

Appearances in Malignant cases USG	USG Appearances	Percentage
HYPO Echoic Mass	11	100%
MICRO Calcification	11	100%
Absent Halo Sign	11	100%
Invasion of strap muscles	3	100%
Lymphadenopathy	11	100%
Intra lesional vascularity	11	100%

Table 6: Comparative features of malignant cases on USG & FNAC

Features	Ultrasonography	Cytology
Hypo echoic Mass	22%	19%
Micro calcification	18%	18%
Absent Halo sign	18%	19%
Invasion of strap muscles	5%	5%
Lymphadenopathy	18%	19%
Intra lesional vascularity	18%	19%

Table 7: Evaluation of Ultrasonographic criteria for diagnosis of Adenoma

Criteria	Cases	Others	Sensitivity	Specificity	PPV	NPV
Hyperchoic	6/9	1/41	66.67%	97.56%	59.23%	94.93%
Isoechoic	3/9	1/41	33.33%	97.56%	42.66%	90.23%
HALO+	9/9	30/41	100.0%	26.82%	22.75%	100.0%
Perinodular Vascularity	9/9	1/41	100.0%	92.85%	72.75%	100.0%

Microcalcification, Absence of Halo, Lymph Node, and Intralesional Vascularity are the most sensitive indications of malignancy (sensitivity 100%), while Invasion is just 27.27% sensitive. The most accurate diagnosis is LYMPHADENOPATHY (85.18%), even if the sensitivity for INVASION is 100% but there are only 3 cases present, therefore it may be 100% but its actual value cannot be predicted. Gray scale ultrasound revealed heteroechogenicity and coarse calcification to be typical thyroiditis findings, but they were not very sensitive for the condition (63.63% and 72.72%) and only demonstrated a specificity of 75 to 85%. In contrast, color flow imaging demonstrated a sensitivity of 90.90% with a positive thyroiditis prediction rate of 85.57%.

Table 8: Ultrasonographic Evaluation of Malignancy in Thyroid Nodule

Criteria	Malignant Nodule	Other nodule diseases	Sensitivity %	Specificity %	PPV	NPV	X2	p-value
Hypo echoic	11/11	8/39	100%	81.48%	36.5%	94.5%	4.99	<0.001
Micro calcification	11/11	10/39	100%	75.18%	29.0%	95.4%	3.18	<0.001
Absent Halo sign	11/11	17/39	100%	55.55%	24.0%	100%	4.23	<0.001
Lymphadenopathy	11/11	6/39	100%	85.18%	23.0%	100%	11.9	<0.001
Invasion of strap muscles	11/11	0/39	27.27%	92.15%	50.0%	92.29%	5.61	<0.001
Intra lesional vascularity	11/11	10/39	100%	74.07%	36.46%	100%	8.4	<0.001

Table 9 makes it clear that ULTRASOUND and CYPTO work best together to diagnose THYRODITIS, ADENOMA, and colloid abnormalities, with THYRODITIS having the greatest predictive value.

Table 9: Ultrasonographic and Color Flow Imaging of Thyroid Disorders

Criteria	Sensitivity	Specificity	PPV	NPV	X2	p-value
Malignant nodule	100%	94.75%	44.44%	100%	2.02	p>0.05
Thyroiditis	100%	100%	100%	100%	8.07	p<0.001
Adenoma	93.75%	100%	100%	98.82%	4.1	p<0.001
Colloid	100%	96.72%	95.12%	100%	8.04	p<0.001

Discussion

The majority of individuals in our study who had thyroid swellings when they were first diagnosed were females between the ages of 30 and 60. In a prospective study of 100 participants in North America, Ezzat et al.[3] discovered a higher prevalence in women (72%) compared to men (41%) (P=0.02), with a mean age range of 43 to 50 years.

Out of 50 patients, we identified 19 as colloid on USG, of which 17 were later determined to be colloid goitres on FNAC. The majority of the cases displayed discernible anechoic cystic alterations. On ultrasonography, anechoic echo patterns with Comet tail artifacts and typical vascularity were the most prevalent. Depending on the stage of the disease, the ultrasound appearance varies significantly, but the common pattern is one of poorly echogenic nodules, lobular contour foci of increasing echogenicity reflecting fibrosis, and anechoic degenerative zones.[7]

The relevance of a comet tail artefact in a thyroid nodule was reported by Ahuja et al. in 1996. They examined 100 patients, and found that copious colloid was present on F.N.A.C. in 85% of those with this artifact, indicating that the artifact may be connected to the presence of colloid. We recognized the comet tail artifact in several cases that ultrasonography initially misdiagnosed as colloid nodules but which ultimately proved to be comet tails on F.N.A.C. in every case.[8] According to our research, anechoic echo patterns with normal vascularity on color flow imaging and comet tail artifacts are the most typical echo patterns detected on ultrasound.

Out of 50 cases, thyroiditis was discovered in 11 on USG and 10 on FNAC. Heterogeneous with diffuse vasculature and septa forms was the most typical ultrasonic echo pattern. Of the 11 thyroiditis cases, 10 showed diffuse vasculature, 7, hetero echogenicity, 3, hypochoic ecotexture, 1, and coarse calcification. According to Langer et al.,[9] localized thyroid nodules that were later determined to be lymphocytic thyroiditis appear sonographically as solid hyperechoic nodules with poorly defined edges. However, there were calcification and lesions that appeared cystic, and the echogenicity was inconsistent. On Doppler, these nodules showed a wide range of vascularity. Biopsy of these lesions is still necessary because there are no Sonographic features that can reliably diagnose these lesions as thyroiditis and differentiate from other lesions.

The usefulness of color Doppler sonography in patients with subacute thyroiditis was investigated by Hiromastu et al.[10]. In the afflicted enlarged thyroid during the acute state of sub-acute thyroiditis, CDS demonstrated poor echogenicity without enhanced tissue vascularity.

CDS exhibits isoechogeneity and a small increase in vascularity during the recovery period. At one year after treatment, vascularization returned to normal; in contrast, much more vascularization was seen in untreated patients. A quick, non-invasive approach for separating SAT from other disorders is CDS.

According to the results of our investigation, heterogenous ecotexture with diffuse vascularity and coarse calcifications was the most frequent echo pattern found on USG.

Out of 50 thyroid nodules examined, 10 FNAC tests and 11 USG tests identified 11 as adenomas. The hyperechoic nodule with existing perinodular vascularity and halo was found to be the most sensitive and specific USG characteristic for the identification of an adenoma. Hyperechoic echo patterns are the most prevalent, with 75% sensitivity and 89.89% specificity.

In order to determine whether it is possible to identify autonomous thyroid adenomas using color Doppler and internal hyper vascularization, Becker et al.[11] prospectively studied 53 thyroid nodules. The internal hyper vascularization of 28 of the 29 individuals with autonomous adenomas results in a sensitivity of 96% and a specificity of 75%. Interestingly, color Doppler found 6 adenomas in patients showing normal lab results. Color Doppler has a 94% negative predictive value and can be utilized to rule out localized adenomas.

According to the findings of our inquiry, the most sensitive and specific USG characteristic for the diagnosis of an adenoma is a hyperechoic nodule with perinodular vascularity and a halo. Out of 50 cases, 10 cases on FNAC and 11 instances in the USG were confirmed as malignant. The absence of a halo, lymphadenopathy, vascularity, and microcalcification were the most trustworthy symptoms. Hypoechogenicity was the most typical echo pattern observed on USG.

According to Solbiati et al[12] analysis, USG has good sensitivity and specificity for detecting lesions, characterizing diseases, and differentiating benign from malignant lesions. These properties could be further enhanced by using harmonic imaging and ultrasonic contrast agents. A mixture of numerous indicators can significantly aid in accelerating the diagnosis procedure, even though no one indicator is specific for determining whether the lesions are benign or malignant. The most reliable method for making a final determination on thyroid gland nodules is still FNAB (cytology).

26 individuals with cold thyroid nodules (5 malignant and 21 benign) were prospectively investigated by Erdem et al. to determine the use of Tc 99m scintigraphy and color Doppler sonography in distinguishing malignant from benign thyroid nodules. Scintigraphy and color doppler were shown to have 100%, 85%, 62%, and 50% sensitivity, specificity, negative predictive value, and positive predictive value, respectively. They came to the conclusion that the ability to detect malignant thyroid nodules using color Doppler sonography appeared to be restricted.[13]

In order to assess "cold" thyroid nodules, Rago et al. investigated the effectiveness of conventional thyroid USG and CD sonography. On US, the absence of a halo sign, which was present in 20/30 CA and 17/72 BN (exactly 77.0%; sensitivity 66.6%, p value 0.0001), was the echographic pattern most indicative of malignancy. In 8/30 CA and 5/74 BN, the most specific US combination—absent halo sign/micro calcifications—was discovered. On the CFD, the type III pattern was discovered in the 20/30 CA and 38/74 BN. Only when several symptoms are present in a thyroid nodule at the same time can US and CFD become strongly predictive for malignancy.[14] To the best of our knowledge, as evidenced by earlier investigations by Katz et al. & Clark et al., it can be challenging to discern between benign and malignant nodules.

According to our research, the absence of a halo, lymphadenopathy, vascularity, microcalcification, and Hypoechogenicity were the most trustworthy indications.

Conclusion

Finally, gray scale ultrasound outperforms clinical palpation and examination in assessing thyroid morphology by distinguishing between single and numerous nodules and determining whether they are solid or cystic. It can accurately diagnose thyroiditis or toxic goitre adenoma lesions as well as consistently distinguish benign from malignant lesions. Color flow imaging has improved the ability to predict thyroid pathology, particularly toxic goitre and thyroiditis, but FNAC/Biopsy is still required to provide a conclusive diagnosis.

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