Sonographic evaluation of thyroid lesion with FNAC correlation

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Abstract
Background and Objectives: The thyroid gland is critical in regulating metabolic functions of the body. High resolution sonography is the imaging modality of choice by which normal anatomical and pathological features of thyroid can be demonstrated. In this study the ultrasonographic features of various thyroid lesions in patients with thyroid disorders is evaluated and these sonographic findings were correlated with FNAC.
Method: The present study included 70 patients with clinically palpable thyroid swelling. The patients included in the study were subjected to gray scale and colour Doppler examination of the thyroid gland and fine needle aspiration cytology and histopathological examination.
Stastical Analysis: The data was analysed by SPSS 26.0 with independent chi square test.
Results: It is a cross sectional study in which various sonographic features such as size, echotexture of thyroid gland and nodules were evaluated based on
size, shape, margins, contents, echotexture, calcification and halo. Based on ultrasound these lesions were classified as benign and malignant. FNAC from these lesions were obtained and was sent for evaluation. The FNAC findings are correlated with sonographic findings. Malignant lesions identified as malignant on USG was confirmed as malignant on FNAC also.
Conclusion: Ultrasound is the best imaging modality for thyroid gland. The combination of ultrasonography with FNAC, rather than a single modality, helps detect malignant nodules and timely surgical intervention.

Keywords: High Resolution Ultra Sonography (HRUSG), Fine Needle Aspiration Cytology (FNAC), Thyroid Nodules, Benign, Malignant

Introduction
Disorders of thyroid gland are amongst the most common endocrine and surgical problems encountered in clinical practice. The prevalence of thyroid nodules is about 3%-8% in the general population and is greater than 50% after age 65 years [1, 2]. The profile of thyroid disorders encountered in paediatric and adolescent age groups in India is similar to that seen in most parts of the world except for the prevalence of iodine deficiency disorders in certain endemic regions of this country. Clinical presentation is most commonly for hypothyroidism, goitres and infrequently for hyperthyroidism [3]. Clinical surveys have shown that 5-10% of the general population have thyroid pathologies including nodular lesions in 2.5-3% of cases [4]. The prevalence of hyperthyroidism is 2% in females and 0.6 % in males, hypothyroidism 4.8 % and 0.9% and goitre 2.9% and 0.4% respectively. In both sexes the prevalence increased with age [5]. Thyroid sonography was first introduces in 1966- 1967 [6]. It has been widely practiced since the 1970 and is now one of the most popular radiological methods of diagnosing thyroid disease [7]. Sonography is commonly the first imaging modality after clinical examination.

On the basis of the sonographic findings selection of additional imagining modalities including CT and MRI imaging can be applies more judiciously. Fine needle aspiration cytology (FNAC) is now a well-established, first line, simple and quick screening test as well as the diagnostic tool for surgical and non-surgical goitres. Limitation of FNAC is mainly because of inadequate sampling, in experience of the pathologist and over lapping cytological features [8]. Ultrasonography is an easily accessible, non-invasive way to image the thyroid gland and its pathology. It helps to pin point a possible thyroid abnormality at an early stage and includes the elements of differential diagnosis that result in subsequent thorough examination and timely treatment in appropriate cases. In addition to facilitating the diagnosis of clinically apparent nodules, the wide spread use of ultrasonography has result in uncovering a multitude of clinically unapparent thyroid nodules, while differentiating majority of them which are benign from malignant nodules. The present study was aimed to determine the role of high resolution ultrasonography in the evaluation of lesions of the thyroid with FNAC correlation and compare with other studies.

Aims and Objectives

1. To study the ultrasonographic features of various thyroid lesions in patients with thyroid disorders.
2. Correlate the sonographic findings with FNAC in the diagnosis of thyroid lesions.

Materials and Methods

The present prospective study was conducted in the Department of Radiology in association with the Department of Pathology of Saraswathi Institute Of Medical Sciences, Hapur. This study includes a total of 70 patients during the period September 2022 to August 2023.

Inclusion Criteria

1. Age group10-80 years
2. Patients with thyroid disorder with USG showing thyroid lesion
3. Patient giving consent

Exclusion Criteria

1. Patients with bleeding disorders
2. Previously diagnosed cases of benign disease and thyroid malignancies.
3. Cases undergoing treatment.
4. Patient refusal for FNAC

Examination method

A brief history was taken and physical examination was carried out. Patients were subjected to high resolution ultra-sonographic (HRUSG) examination and the suspected lesions are further subjected to fine needle aspiration cytology following informed verbal consent. The Ultra sound machine used was canon xario 200 with a 4 to 12 MHz linear probe.

Technique of USG neck

The thyroid gland was located superficially and hence high resolution real time ultrasonography can demonstrate normal thyroid anatomy and pathological conditions with remarkable clarity. High frequency transducers (7.5 -15.0 MHZ) currently provide both deep ultrasound penetration up to 5 cm and high definition images with a resolution of 0.7 -1.0 mm. Linear array transducers are preferred to sector transducers because of wider near field of view. Thyroid nodules were assessed according to margin, echogenicity, calcification, internal vascularity, internal contents, circumferential halo, and associated lymphadenopathy. The margin was divided into a well-defined and ill-defined border. The echogenicity of the lesion as compared to the thyroid gland is termed hypoechoic(lower echogenicity to that of the thyroid gland), hyperechoic (more echogenic to that of the thyroid), and isoechoic (same echogenicity as that of the thyroid gland). Calcification was termed microcalcification(measuring about 10 mm) and macrocalcification(measuring more than 10 mm). The presence of central and peripheral vascularity was noted. Internal contents were recorded as solid or cystic areas within thyroid nodules.

Technique of FNAC of thyroid lesion

The swelling was uncured with 23 G needle attached to a 10 cc disposable syringe after cleaning and draping the patient. The material was aspirated from the swelling and two smears are made. First slide was air dried and second was fixed wet in ether. Air dried smear was stained with MGG stain, while ether fixed smear was stained with H&E.

Statistical analysis: The data was expressed in number and percentage. Chisquare test applied to find the statistical significant. P value less than 0.05 considered statistically significant at 95% confidence interval.

Results

In a prospective study of a total of 70 patients, 59 (84.3%) were female and 11 were male (15.7%) with a male: female ratio of 1:1.8. Age was ranging from 20 to 76 years with a mean age of 48.6 ± 13.2 years. Among total patients, 49 patients had benign nodules and 21 had malignant nodules. Malignancy was detected in 18 female patients and three males patients. While eight male patients and 41 female patients had benign nodules. There was a significant correlation between ultrasonographic features with FNAC reports as evidenced by a p-value of < 0.05.

In our study, there was a significant correlation between ultrasonographic and FNAC findings in the differentiation of benign from malignant nodules as evidenced by $p < 0.05$ calculated by Pearson's chi-square test.

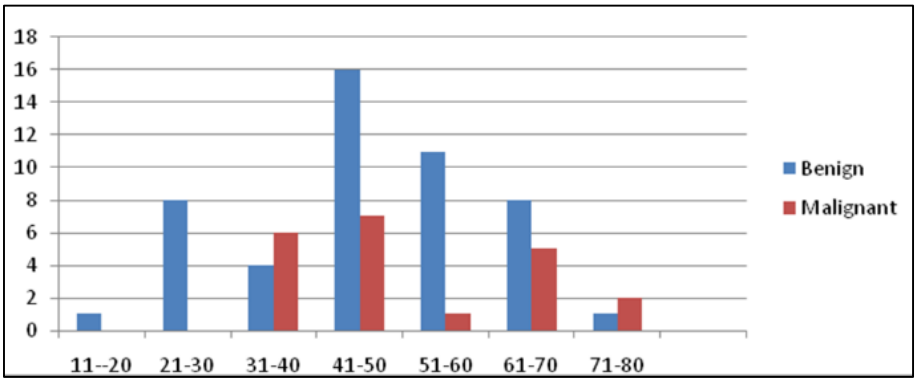

Fig 1: Distribution of thyroid nodule according to age

Table 1: USG characteristics of thyroid nodules with FNAC result

Parameters	Benign	Malignant	Total
No. of Nodules			
Single	34	17	51
Multiple	15	4	19
Margin			
Well defined	47	10	57
Poorly defined	2	11	13
Echotexture			
Hypoechoic	5	12	17
Isoechoic	18	3	21
Hyperechoic	23	0	23
Markedly Hyperechoic	3	6	9
Internal content			
Solid	8	9	17
Predominantly Solid	20	12	32
Predominantly Cystic	16	0	16
Cystic	5	0	5
Halo			
Present	25	1	26
Absent	24	20	44
Calcification			
Macro-Calcification	22	4	26
Micro-Calcification	4	12	16
Absent Calcification	23	5	28
Vascularity			
Central Vascularity	2	10	12
Peripheral Vascularity	9	2	11
Both	5	8	13
Absent	3	31	34

Table 2: Various USG features in diagnosis of malignant nodule

USG Features	Sensitivity	Specificity	PPV	NPV	Accuracy
Hypoechoic	83.3%	100%	100%	71.4%	88.2%
Single Nodule	70.5%	91.9%	80%	86.1%	89.5%
Ill Defined	100%	50%	91.6%	100%	92.3%
Solid	87.5%	85.7%	87.9%	85.7%	86.6%
Absence of Halo	70%	87.5%	82.3%	77.7%	79.5%
Micro-Calcification	91.6%	50%	84.6%	66.6%	81.2%
Central Vascularity	75%	100%	100%	75%	85.7%
Overall USG	72%	91.8%	78.9%	88.2%	85.7%

Table 3: Comparison of sensitivity, specificity of our study with various authors

	Chinta Vittal Prasad		Sharma Gururaj		Current Study	
	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
Ill Defined margins	80%	87%	78.5%	82.3%	100%	50%
Hypoechoic echostructure	72%	88%	85.7%	67.7%	83.3%	100%
Micro- Calcification	68%	87%	78.5%	77.4%	91.6%	50%
Absence of Halo	-	-	64.2%	53.2%	70%	87.5%
Central vascularity	64%	84%	85.7%	64.5%	75%	100%

Discussion

In our study, there was female predominance constituting 84.3% (59 cases) and male accounting for 15.7% (11 cases). A higher incidence of female patients was documented by other studies conducted by various workers [9]. The age group with a higher percentage of thyroid nodules was at 41-50 years similar to the study of Manoj *et al*. showing most of the patients in the 40–49year age group [10]. The youngest age was 20 years old and the eldest was of 70 years old in our study. This finding was similar to Singh *et al*. who reported 18 years of age as the youngest and the oldest being 75 years [11]. The mean age was 48.6 ± 13.2 years in our study. Gyawali *et al*. and Nazir *et al*. had mean age in little younger age which was 38 ±7.3 years and 38.91±10.85 years respectively [12, 13]. In 30 % of patients had malignant nodules in our study which was a little higher than that of Chen *et al*. who had an incidence of malignancy of 23.5% [14]. Sharma *et al*. documented incidence of malignancy in 10.1% of thyroid nodules and Nazir *et al*. had still lower incidence of 6% in the study [13, 15]. In 41-49 years age group was the most commonly affected age group with thyroid malignancy which constituted 30.4% of cases. Similarly, 41-50 years was the predominant age group among malignancy which was found in the study conducted by Singh *et al* [11].

In a study conducted by Brown, thyroid malignancy was encountered in a single thyroid nodule and none of the multiple nodules had evidence of malignancy [16]. In our study, multiple nodules accounted for 27% similar to a study conducted by Brown, out of which 21.6% were benign and 5.4 % were malignant.

About 62% of hypoechoic nodules were malignant in a study reported by Solbiati *et al* [17]. Similarly in our study, the incidence of malignancy was more prevalent in hypoechoic nodules and benign lesions were commonly encountered in hyperechoic followed by isoechoic nodules. 57.1% of cases with hypoechoic echotexture had malignant nodules and 46.9% of nodules with hyperechoic echotexture had benign entities in our prospective study. Usually, macrocalcification which is large, nodular, coarse is predictive of benign variety, and fine, punctate calcification comprises malignant variety. Punctate calcification is usually the result of psammoma bodies of papillary thyroid carcinoma. Singh *et al*. reported in their study that calcification was found in 9 cases (18%) out of 50 patients. Nodular calcification was seen in 33.33% of cases [11]. Out of which, 22.22% cases were benign and 11.11% cases were malignant. Similarly, 33.33% of cases had fine calcification. Out of which, 22.22% cases were malignant and 11.11% cases were benign. All the cases with coarse calcification, which accounted for 33.33%, were benign in his study.

In total, 42 (60%) out of 70 patients had calcification in thyroid nodule in our prospective study. Among which, 61.9% % had macrocalcification, out of which 52.8 % were benign and 9.5% were malignant; 38% had microcalcification, out of which, 9.5% were benign and 28.5% were malignant. Thus our study also clearly demonstrated that microcalcification is a predictive sign of malignancy similar to Singh *et al* [11].

A thin, complete peripheral halo, usually represents blood vessels around the periphery of the lesion which is highly predictive of benign nodules. Peripheral halo was present in 36% of cases in a study by Singh *et al*. and all of them were benign. Halo was reported in 36% of thyroid nodules in a study by Solbiati *et al*. and 86% accounted for benign and 14% comprised for malignant abnormality [11, 17].

Similarly, in our study, 37.1% had the presence of a halo. Out of this, 96.1% accounted for benign nodules and 3.8 % accounted for malignant nodules.

In a study by Singh *et al*., 10% of cases of thyroid nodules with irregular margins showed that all of them were malignant [11]. Solbiati *et al*. reported that 55% of thyroid nodules with irregular margins were malignant [17]. However, in our study, 15.7% of nodules with an ill- defined margin had malignancy.

The sensitivity, specificity, positive predictive value, and negative predictive value of ultra- sonography when correlated with FNAC were 64%, 81%, 53%, and 87% respectively in a study by Prasad CV [18].

In a study by Kapali *et al*. the sensitivity of ultrasound in diagnosing malignant nodules was 88.4%, specificity was 73.3% and the overall accuracy was 80.3% [19].

Our prospective study demonstrated an overall sensitivity of 72%, specificity of 91.8%, the positive predictive value of 78.9%, the negative predictive value of 88.2%, and accuracy of 85.7% of ultrasonography in detecting malignant nodules. Our sensitivity was lower than that of Kapil *et al*. as there were some overlapping ultrasonographic features of the malignant nodules and that of the benign nodules. However overall accuracy was a little higher than that of Kapil *et al* [20] Irregular border, hypoechoic echotexture, absence of halo, solid content with marked central vascularity, microcalcification were the important ultrasonographic hallmark features of malignancy. FNAC is the gold standard diagnostic mode of detecting malignant nodules. However, there are certain limitations in cases of inadequate and indeterminate samples. About 4-15% of all cases had undetermined results even inadequate samples. So there are chances of false positive and false-negative cases.[21] However, there was a significant correlation between ultrasonographic and FNAC findings in differentiation benign from malignant nodules, as evidenced by $p < 0.05$ in our overall study. Similarly, it also documented that ultrasonographic features in diagnosing malignancy had statistically significant p-value < 0.05 [22].

Conclusion

Ultrasonography is the most accurate and specific modality in differentiating benign from malignant nodules and is the best imaging modality after clinical examination due to the superficial location of the thyroid gland. The combination of ultrasonography with FNAC, rather than a single modality, helps detect malignant nodules and timely surgical intervention. In addition, ultrasound also allows visualization of whole thyroid glandular parenchyma and local invasion to adjacent neighboring structures along with cervical lymphadenopathy in suspicious cases.

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