ULTRASONOGRAPHY OF THYROID NODULES- IS IT WORTHWHILE?

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ABSTRACT

BACKGROUND

Thyroid nodules are one of the commonest neck swellings encountered by ENT surgeons today. The diagnostic difficulty lies in the assessment of the nature and behaviour of such masses. A large proportion of these swellings is of a benign nature, which makes invasive diagnostic procedures unnecessary. Of the various diagnostic options available, ultrasonography (USG) appears to be the most easily accessible. The present study attempts to study the USG characteristics of thyroid nodules in a set of patients presenting to the ENT clinic with no clinical evidence of thyroid dysfunction.

MATERIALS AND METHODS

38 patients reporting to the ENT clinic with palpable thyroid nodules were taken in the study. After a thorough clinical examination for evidence of thyroid dysfunction, the patients were subjected to ultrasonography of the thyroid nodules. The USG characteristics were studied in comparison to similar studies by other authorities with regard to the likelihood of malignancy.

RESULTS

In the present study, the largest number of cases were in the age groups of 31-40 and 41-50 and females outnumbered the males. The range of USG features studied were - echo texture, internal contents, presence of halo, margins, calcification and Doppler studies. The features had a broad range and combinations of these features which would help the radiologists and clinicians to decide the need for further invasive studies.

CONCLUSION

Ultrasonography is the most easily available and inexpensive mode of investigation for a study of thyroid nodules in patients presenting with neck swellings. While it is not absolutely conclusive, it does give us a fair idea of the behaviour of the nodules. Some of the USG features suggest a pattern of rapid growth and aggressiveness, while others appear to be benign. As a preliminary investigation, USG studies will guide the requirement of invasive tests like fine needle aspiration cytology in selected cases and permit conservative management of the rest.

KEYWORDS

Thyroid nodule, ultrasonography, Doppler, cyst, calcification.

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BACKGROUND

Neck swellings form an important part of the case load of an ENT surgeon today. This is more so after the inclusion of head and neck surgery in the domain of otorhinolaryngologists. Of the different varieties of midline neck swellings, thyroid swellings are most common as well as the most diagnostically challenging. The problem is even more acute in cases of thyroid nodules. This is because these nodules may be nonfunctional or hypersecreting, benign or malignant. The American Thyroid Association defines thyroid nodules as "discrete lesions within the thyroid gland, radiologically distinct from surrounding thyroid parenchyma." Thyroid nodules may be single or multiple and may be accompanied by a diffuse swelling of the thyroid gland or even with enlarged cervical lymph nodes.

The presentation of thyroid nodules may be varied – the patient may be aware of thyroid nodularity for a considerable period of time, the patient himself being either euthyroid or hyperthyroid. On the other hand, the patient may be alarmed to suddenly feel a solitary thyroid nodule and be quite anxious about it. Nodules in the thyroid gland may also be detected by the clinician while palpating the neck for thyroid pathology. The true prevalence of thyroid swelling by autopsy studies is around 50%, even though they may be clinically normal in life. Whatever the setting, the presence of a midline neck swelling is definitely a cause of anxiety as the main task of the clinician is to search for other similar thyroid nodules, investigate their nature and eliminate the possibility of malignancy.

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Epidemiologically it is seen that in the USA, 4% to 5% of the adults have thyroid nodules, which again is commoner in women.[1] In many studies, USG detected thyroid nodules are subjected to Fine Needle Aspiration Cytology. About 70% of thyroid nodules are benign, 5% are frankly malignant and 25% are suspicious for malignancy.[2] The most common benign lesions include colloid nodule, follicular adenoma, and lymphocytic thyroiditis, among others. The most common malignant lesions are papillary carcinoma, followed by follicular carcinoma, medullary carcinoma, anaplastic carcinoma, and metastatic lesions.

Ultrasonography has evolved as the most-simple, cost effective and non-ionizing imaging modality in the diagnosis of thyroid nodules. The equipment is available in most secondary and tertiary care medical centres and requires almost no patient preparation. It is effective in measuring the size of the nodules under study and is little affected by movements of the neck. In addition, USG also enables the detection of enlarged deep cervical lymph nodes. All suspicious lesions may be followed up by fine needle aspiration cytology.

In the present study, a population of patients presenting with nodules of the thyroid gland were examined by ultrasonography to determine the nature of the lesions and the range of acoustic shadows displayed by them. Based on the diagnostic indecision or likelihood of malignancy, some of these cases would be followed up by fine needle aspiration cytology.

Aims and Objectives

- To differentiate thyroid nodules from other cervical masses before going for operative decision.
- To study the USG features of different types of nodules.
- To differentiate benign and malignant lesion on basis of sonographic features.

MATERIALS AND METHODS

The study was carried out in the Department of Otorhinolaryngology and Head and Neck Surgery of Malda Medical College over a period of 6 months. The descriptive case series study was carried out on a population of 38 patients presenting with clinically palpable thyroid swellings, either median or paramedian and moving with deglutition.

The parameters to be studied included-

- Determine age and sex distribution of palpable neck mass.
- Characterize USG features of benign or malignant enlargement of thyroid.

The study tools were as follows-

- Demographic data: name, age, sex, address, occupation, socioeconomic status.
- Detailed history and thorough examination of patients.
- Ultrasonography.

The heart of ultrasonography technology is a probe that contains a piezoelectric crystal called a transducer. Electrically induced vibrations of the crystal generate the ultrasonographic beam which penetrates tissue to different depths and is reflected by internal tissues. The reflected beam is sensed by the same probe which also acts as a receiver. A semi fluid medium like a gel is applied to the neck for better contact between the probe and the skin of the neck. The signal is organized electronically into numerous shades of gray and is processed electronically to produce an image in real time. Although each image is a static picture, rapid sequential frames are processed electronically to depict motion.

Dynamic information such as blood flow can be added to the signal by employing the Doppler Effect. The absence of flow in a fluid filled structure can differentiate a cystic structure and a blood vessel.

Blood flow within anatomic structures can also be depicted by non-Doppler technology that is called B-flow ultrasonic imaging. This is accomplished by transmitting precisely separated adjacent ultrasound beams and computer analyzing the reflected echo pairs.

Ultrasound is helpful in the evaluation of thyroid nodules, distinguishing solid from cystic ones, and providing information about size and multicentricity as well as assessment of cervical lymphadenopathy and to guide FNAC.

Inclusion Criteria

All patients presenting in the otorhinolaryngology outdoor with history of neck midline swelling in front of the neck and moving with deglutition

Exclusion Criteria

Patients presenting with neck swelling.

- Not moving with deglutition
- Having deranged thyroid profile (t3 t4 TSH)

RESULTS

Age in Years	Sex					
	Male		Female		Total	
	No.	%	No.	%	No.	%
11-20	0	00	02	5.23	02	5.23
21-30	02	5.23	06	15.69	08	21.04
31-40	05	13.18	08	21.04	13	34.22
41-50	04	10.52	08	21.04	12	31.58
51-60	00	00	03	7.9	03	7.9
Total	**11**	**28.03**	**27**	**71.07**	**38**	**100**

Table 1. Age and Sex Distribution of Thyroid Swelling Cases

In the study, the youngest patient was 11 years of age and oldest 58 years. The maximum number of cases were in the age groups of 31-40 (34.22%) and 41-50 (31.58%) and females dominated (71.07%) over males (28.03%).

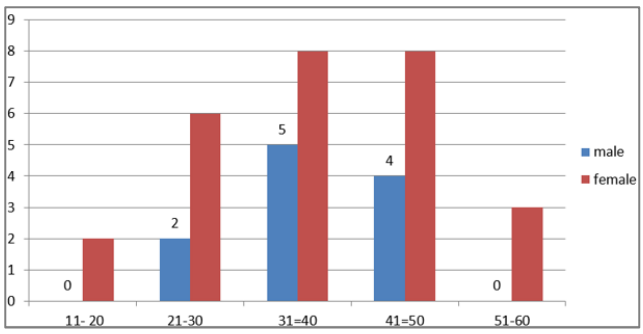

Figure 1. Age and Sex Distribution of Thyroid Swelling Cases

	No. of Cases (n = 38)	Percentage
Echo Texture (n = 38)		
Isoechoic	2	5.26
Hypoechoic	15	39.47
Hyperechoic	16	42.10
Heterogenous	4	10.52
Anechoic cyst	1	2.63
Internal Contents (n = 38)		
Purely cystic	19	50
Cystic with thin septa	12	31.58
Mixed solid and cystic	04	10.53
Comet tail artifact	03	7.89
Halo (n = 38)		
Thin halo	12	31.58
Thick incomplete halo	03	7.89
No halo	23	60.53
Margin (n = 38)		
Well defined	33	86.84
Poorly defined	05	13.16
Calcification (n = 38)		
Egg shell	01	2.63
Micro	11	28.95
Coarse	04	10.53
No calcification	22	57.89
Doppler (n = 38)		
Peripheral flow	19	50
Internal flow	15	39.47
No flow	04	10.53

Table 2. Distribution of Lesions According to USG Characteristics of Nodules

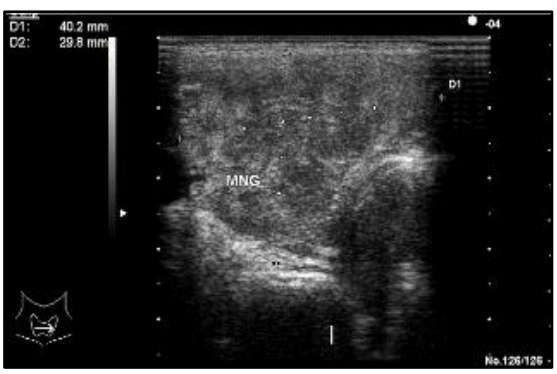

Figure 2. Multi Nodular Goiter in Right Lobe

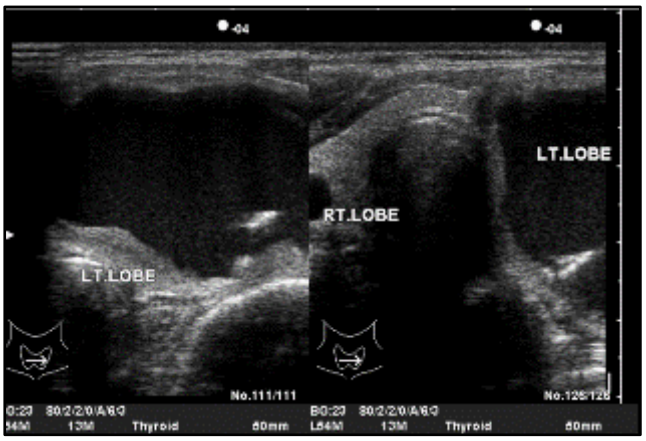

Figure 3. Colloid Cyst in the Left Lobe of Thyroid Gland

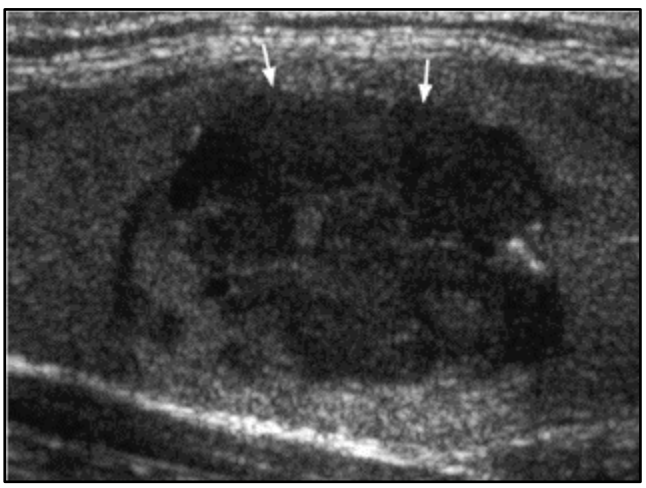

Figure 4. Thyroid Mass with Cystic Changes

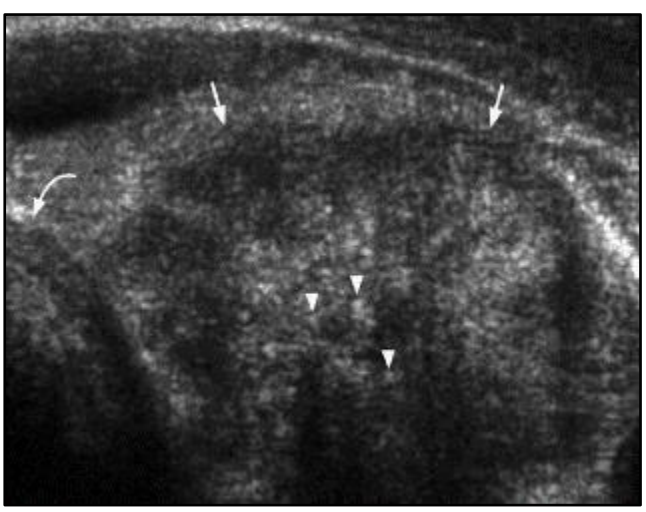

Figure 5. Thyroid Mass with Multiple Micro Calcification

DISCUSSION

The present study was carried out on a set of patients who were clinically euthyroid but at the same time presented with thyroid nodules.

Thyroid nodules are commonly found in the general population. Based on long term, large cohort health studies such Framingham, Massachusetts series, it is estimated that 4-8% of the general population have thyroid nodules.[3] Other

studies show that nodule prevalence increases from 30% in patients younger than 50 years to 50% in patients greater than 60 years of age.[4] Due to anatomic factors, approximately 90% of all thyroid nodules are not palpable.[5,6] Furthermore half of patients with clinically apparent solitary nodules are found to have nonpalpable multinodular goiters on ultrasonography[7] or surgical thyroidectomy.[8] Nodules are more common as age increases and as iodine intake decreases and they occur more frequently in women.

Pediatric thyroid carcinoma presents most commonly in the teenage years and in girls 5.6 times more often than in boys.[9] In patients greater than 70 years old, malignant disease is not as common, but when present it has a worse prognosis.[10] Gender is also important: when a thyroid nodule is present, the risk of malignancy in men is twice that of women.[11]

In the present study, the maximum number of cases was seen in the age group 31-40 years in both males and females. Females (71.7%) with thyroid nodules outnumbered the males (28.3%) (Table 1, Figure 1).

Although not mutually exclusive, five categories of thyroid nodules represent the spectrum of pathology - hyperplastic, colloid, cystic (containing fluid), inflammatory (thyroiditis) and neoplastic (papillary carcinoma, follicular carcinoma, anaplastic carcinoma, medullary carcinoma, lymphoma).[12] Of the malignant tumors, 90% are differentiated thyroid cancers, 5-9% are medullary thyroid cancers, 1-2% anaplastic carcinomas, 1-3% are lymphomas and less than 1% are rare tumors like sarcomas. Of the differentiated tumors, 80% are papillary cancer and 10% are follicular cancers.[13]

A sudden change in the size of a preexisting nodule implicates malignancy. Radiation exposure to the neck places the patient at high risk for the development of both benign and malignant thyroid masses.[14,15]

An earlier perception that solitary nodules are more likely malignant than a nodule within a goiter is now replaced with a general acceptance that the risk of cancer is similar in patients with solitary or multiple nodules.[16,17]

Ultrasonography identifies thyroid nodules, even those that are too small to palpate. Sonography can demonstrate nodules that have an enhanced risk of malignancy and have the best noninvasive sensitivity that is currently available, but with only fair specificity. Ultrasonography should be used clinically to guide needle biopsy.

The ultrasonic appearance of a thyroid nodule does not reliably differentiate a benign thyroid lesion and cancer.[18,19] Furthermore, sonography cannot identify a specific kind of tumor such as a Hurthle cell lesion.[20] There are distinctions in echo density, calcifications, a rim and vascularity that favor a benign or malignant diagnosis among thyroid nodules.[21,22]

Several studies have recognized sonographic morphological patterns that correlate with benign thyroid disease. Biopsying these nodules or goiters is not advised in the interest of cost effectiveness. Four patterns associated with benign disease may be identified - spongiform configuration, cystic and diffuse hyper and hypo echogenicity.[23] One characteristic has borne the test of time - thyroid cancer is rarely if ever hyperechogenic.

Echogenicity

Thyroid nodules can be identified by sonography because they distort the echo pattern of the thyroid gland. Thyroid nodules may be large or small and may lie well within a lobe and be unobtrusive (Figure 2). They may be solid tissue or be interspersed with echo free zones that represent fluid filled hemorrhagic or straw colored degenerative zones. Most thyroid nodules have a less dense ultrasound appearance than normal thyroid tissue and few are more echo dense.[21]

Internal Contents

Especially large benign or malignant thyroid nodules tend to undergo hemorrhagic or cystic degenerative changes (Figure 3). It has been reported that features associated with cancer in a cystic thyroid nodule include more than 50% solid tissue, eccentricity of the cystic space, and micro calcifications.

Halo

A sonolucent rim, which is called a halo may be present around a nodule. This represents a capsule or another interface, such as inflammation or edema, segregating the nodule and the rest of the gland. Doppler technique may demonstrate increased vascularity within a nodule or a halo. A halo around the nodule may be seen with benign or malignant conditions. It suggests that there is an acoustic interface that does not reflect the ultrasound across two different types of histology in the region, the nodule and the surrounding thyroid.[24] Some observers have suggested that cancer should be suspected when the periphery of a halo has a blurred appearance.

Calcification

The most reliable sonographic indicator that a nodule is malignant is observing vascular invasion by the tumor.

Thyroid malignancies tend to be hypoechoic when compared with the rest of thyroid.[25] Most beingn thyroid nodules, which are far more common than malignancies, are also hypoechoic. On the whole, it is reasonably safe to conclude that hyperechoic nodules are probably not cancerous. Therefore, aspiration biopsy of these nodules is not advisable. 42% of cases in the present study were hyperechoic (Table 2).

Micro calcifications are relatively more common in malignant lesions than benign. Micro calcifications have been reported as demonstrating a 95.2% specificity for a thyroid cancer, but a low sensitivity of 69.3%.[26] B-mode ultrasonic imaging may be particularly sensitive in detecting micro calcifications. However, large coarse calcifications and calcifications along the rim of nodule are common in all types of nodules and reflect previous hemorrhage and degenerative changes. 29% of cases in the present study had evidence of micro calcification. Nevertheless, it should be noted that some cancers may demonstrate peripheral

calcification and diagnostic aspiration biopsy may be appropriate to avoid missing a cancer. Interruption and thickening of peripheral calcifications and decreased internal echogenicity of a thyroid nodule with peripheral calcifications are in favor of malignancy. Calcifications in a "solitary" nodule in a person younger than 40 years should raise a suspicion of malignancy. It is useful to note than large calcifications are seen with increased frequency in medullary thyroid carcinoma.

Doppler

An analysis of the hemodynamic characteristics of a nodule by high resolution pulsed Doppler ultrasonography may offer valuable diagnostic insights. Follicular carcinomas may show moderate increase of intra nodular vascularity or only a peripheral rim of color flow. The addition of color flow Doppler imaging to conventional sonography increases the screening sensitivity and accuracy in identifying malignant thyroid nodules.

No single parameter satisfactorily identifies a subset of patients whose nodule should be subjected to biopsy. The best compromise between missing cancers and cost benefit is achieved with at least two "suspicious" ultrasound features. The most useful were nodule shape (taller rather than wide), micro calcifications, blurred margins and a hypoechoic pattern. Enhanced intranodular blood flow on Doppler examination also was reported as a very productive criterion.

On ultrasound papillary carcinoma appears as a predominantly hypoechoic nodule, mostly solid with occasional cystic changes.[27]

On ultrasound follicular carcinomas are predominantly solid, homogenous mostly hyperechoic or isoechoic.

With sonography anaplastic carcinomas are diffusely hypoechoic, with areas of necrosis in, dense amorphous calcifications and nodal or distant metastases.

The sonographic appearance of medullary carcinoma is similar to that of papillary carcinoma - hypoechogenicity, irregular margins, micro calcification, hypervascularity with irregular arrangement of blood vessels and frequent association with metastatic. Lymphadenopathy are the most distinctive features.

Thyroid primary lymphoma is rare and appears as a hypoechoic, lobulated, nearly avascular mass. Large areas of cystic necrosis may occur.

Even though no sonographic feature is pathognomonic for malignancy, the high rates of sensitivity and specificity reported account or the current major role of sonography among all imaging modalities in thyroid nodular lesions. Its use is likely to be complementary, rather than alternative to FNAC which is the most effective method for diagnosing malignancy in a thyroid nodule.[28]

Ultrasound characteristics associated with an increased thyroid cancer risk-

1. Hypoechoic
2. Microcalcification
3. Central vascularity
4. Irregular margins
5. Incomplete halo
6. Tall > wide
7. Documented rapid enlargement of a nodule

Ultrasound characteristics associated with low thyroid cancer risk-

1. Hypoechoic
2. Large, coarse calcifications (except medullary)
3. Peripheral vascularity
4. Looks like puff pastry, non hypervascular spongiform appearance
5. Comet tail shadowing

CONCLUSION

Ultrasound is the cost effective modality of imaging and also the investigation of choice in thyroid diseases.

Ultrasound in this study of 38 patients was found to be highly effective for assessing the morphological structure of the gland along with the gland size. It helps to know clearly whether the lesion is solitary or multiple. It helps to clearly differentiate between solid and cystic lesions. Ultrasound helps to differentiate benign lesions from malignant thyroid lesions in most of the cases. The characteristic of benign lesions are well defined margin, thick sonolucent halo, purely cystic lesions which can be clearly depicted by ultrasound. This modality of investigation clearly helps to differentiate between micro and macro calcification and lymph node involvement. Being a safe, simple, repeatable and non-invasive investigation without radiation exposure to the patient, it is worthy of being included in routine diagnostic work up.

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