

Role of Ultrasound and Color Doppler in Assessment of Incidental Thyroid Nodules

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Abstract:

Background: Important discovered of incidental thyroid nodules by different imaging like CT or MRI and examination of the nodules by ultrasound to differentiate between the benign and malignant thyroid nodules and assess the vascularity of the nodules by color Doppler. **Aim of work:** The study was done to evaluate the role of US examination and color Doppler in assessment of incidental thyroid nodules **Patient and methods:** We evaluated 50 patients (by ultrasound and color Doppler) with 36 benign thyroid tumors, 14 malignant thyroid tumors. The ultrasound and color Doppler diagnosis was confirmed by histological examination. **Results:** In this study the US diagnosis was correlated with the final diagnosis based on histological examination in 92% of cases, 14 cases 28% were malignant and 32 cases 64% were benign. **Conclusion:** US is a valuable tool in assessment of incidentally detected thyroid nodules in others imaging features as it can show specific morphologic pattern in

differentiating benign form malignant nodules. Ultrasonography can shorten the diagnosis time and reduce the burden on physicians. US diagnosis was correlated with the final diagnosis based on histological examination in most cases.

Keywords: Incidental findings, thyroid nodules, Ultrasound, Color Doppler.

Introduction

The incidental thyroid nodule (ITN) is one of the most common incidental findings on imaging studies that include the neck. An ITN is defined as a nodule not previously

detected or suspected clinically, but identified by an imaging study like MRI ,CT and US that performed for assessment other regions not involved the thyroid .

The majority of ITNs are benign, and small, incidental thyroid malignancies typically have indolent behavior (1).

Sonographic features of incidental thyroid nodule can be useful to differentiate between benign and malignant nodules, the benign criteria is well defined wall, hyper echoic, peripheral vascularity and no calcification but the malignant criteria is solid, more hypo echoic, in addition, irregular margins, shape that was more tall than wide, an intranodular vascular pattern, or micro calcifications. Larger nodule size was not a risk factor for malignancy. Thus, using these criteria to select nodules for FNA (2).

Ultrasonography is the first choice for detecting thyroid abnormalities because of its safety, noninvasiveness, no radioactivity, and effectiveness and also can detect the presence, site, size, shape, and number of thyroid nodules, unilateral or bilateral, margin, echo structure, echogenicity and calcification and can be detect characteristics of malignancy, such as ill-defined margin, irregular shape, hypo echogenicity, heterogeneity, absence of cystic lesion and/or the halo sign, the presence of calcification, and invasion to adjacent organs (3)

The ultrasound features in the ACR Thyroid Imaging, Reporting and Data System (TIRADS) are categorized as benign, minimally suspicious, moderately suspicious, or highly suspicious for malignancy (4)

Color Doppler imaging can assess the blood flow pattern in thyroid nodules, the flow pattern of the nodule divided in to 3 types, type 1 absence of blood flow, type 2 peri nodular and absent or slight intranodular blood flow and type 3 marked intranodular and absent or slight peri nodular blood flow (5).

Patients and methods

This prospective study was conducted between 12December 2018 to February 2020 on 50 patients with incidental thyroid nodules on different radiological imaging's like MRI, CT and US that performed for assessment other regions not involved the thyroid referred from outpatient clinics to the radiology department of Met Gamer oncology center and gave their informed consent and approval of ethics committee. Fifty patients had incidental thyroid nodules diagnosed by US and color Doppler. Patients with incidental thyroid nodules on different radiological imaging's like MRI, CT and US that performed for

assessment other regions not involved the thyroid and these patients underwent ultrasound examination of the thyroid that confirmed the presence of thyroid nodule.

The study was approved by the ethical committee of Benha faculty of medicine. An informed written consent in Arabic language was obtained from all participants. It included all details about the study (title, objectives, methods, expected benefits and confidentiality data)

The use of high frequency probe which could help to localize pathological condition, to visualize the thyroid gland optimally, the patient is placed in the supine position with a pillow underneath the shoulders. The examination should be performed with the neck in hyperextension. The right and left lobes of the thyroid gland should be imaged in the longitudinal and transverse planes (6).

Ultrasound can detect the presence, site, size, and number of thyroid nodules, margin, echo structure, echogenicity and calcification, and can be detect characteristics of malignancy, such as ill-defined margin, irregular shape, hypo echogenicity, heterogeneity, absence of cystic lesion and/or the halo sign, the presence of calcification, and invasion to adjacent organs (3).

Color Doppler examination, the patient was placed in the supine position with hyper extended the neck with avoid swallowing during the examination, using high frequency linear probe of 7-12MHZ. Color flow Doppler examination is performed with biplanar scanning. The amplifier gain is individually chosen in each case to be at a level immediately under the point of appearance of random color noise. Pulse repetition frequency was established at 500–750 Hz, which is useful for slow flow evaluation. Vascularity pattern is evaluated using sagittal and transverse scans performed along the maximum diameter of the nodule (7).

Results

Fifty patients (42 females and 8 males) were included in this study. Their age ranged from 25 to 69 with a median age 45 years. The diagnosis was confirmed by histologic biopsy according to standard histo pathological procedures. Most patients were included in age group between (30-40 years) then between (40-50 years)

As regard age, the mean age of study population is 44.7 years. As regard gender, 16% of patients were males while 84% were females.

Incidental nodule discovered in patients mostly doing CT chest 22 cases, 10 doing CT neck, 14 cases doing MRI and 4 doing neck US for LNS swelling.

Most patients presented by cough (18 cases), 6 patients presented by chest pain 10 patients presented by LNS swelling and 6 patients presented by hoarseness of voice 6 presented by fever and 4 presented others like difficult swallowing and dyspnea

From 50 thyroid nodules 36 were benign and 14 were malignant.

As regard ultrasound findings, we classified type of nodule as Solitary nodule, Multinodule and cystic nodule. Solitary solid nodule represented (64%) of all patients, while Solid Multinodule was 12% of all patients and cystic nodule/s was 24% of all patients, **table1**.

Table (1): type of thyroid nodule according to US

Type of nodule	n	%
Solitary solid nodule	32	64
Soild multinodule	6	12
Cystic nodule/s	12	24

As regard nodular outline, 36 cases showed regular nodular outline (72%) while irregular or ill-defined outline represented in 14(28%) patients (**Table 2**).

Table (2) type of nodular outline according to US

Nodular outline	n	%
Regular	36	72
Irregular or ill defined	14	28

Calcification was obtained in 24 case (52%) which is divided to course or macro calcification (24% of pt.) and micro calcification (28% of pt.) while (48%) of thyroid nodules showed no calcification (**Table 3 and figure 1**)

Table (3) : type of calcification

Calcification	n	%
Macrocalcification	12	24
Microcalcification	14	28
No calcification	24	48

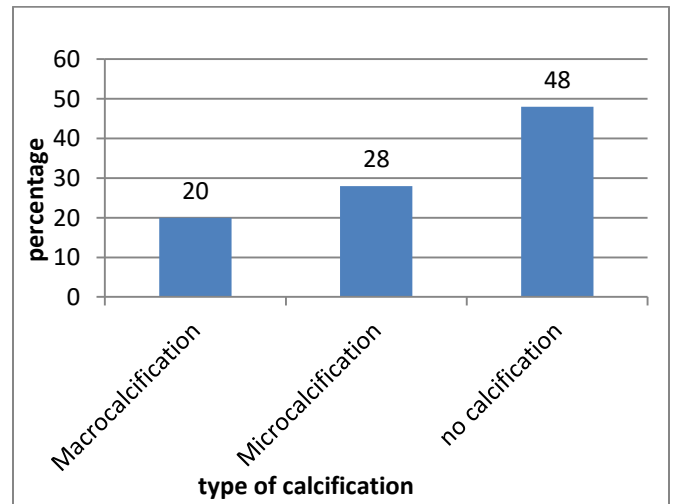


Fig: (1) show type of calcification

The cytological diagnosis of ultrasound-guided fine needle aspiration biopsy of the thyroid was as the following : colloid cyst (24%), papillary carcinoma (20%), follicular adenoma (16%), solitary nodular goiter (24%), multi nodular goiter (8%), medullary carcinoma (4%), and follicular carcinoma (4%). **Table 4**

Table (4) Cytological diagnosis

Cytological diagnosis	n	%
Colloid cyst	12	24
Papillary carcinoma	10	20
Follicular adenoma	8	16
Solitary nodular goiter	12	24
Multi nodular goiter	4	8
Medullary carcinoma	2	4
Follicular carcinoma	2	4

As regard doppler finding and its relation to malignancy confirmed by histopathological examination we found that all cases with malignant thyroid nodules showed increased central vascularity while benign tumors associated with decreased central vascularity in 20 from total 22 case, **table 5**

Table (5) doppler finding

	Malignant tumor	Benign tumor
increased central vascularity	14	2
decreased central vascularity	0	20

In this study the US diagnosis was correlated with the final diagnosis based on histological examination in 92% of cases, 14 cases 28% were malignant and 32 cases 64% were benign, **figure 2**

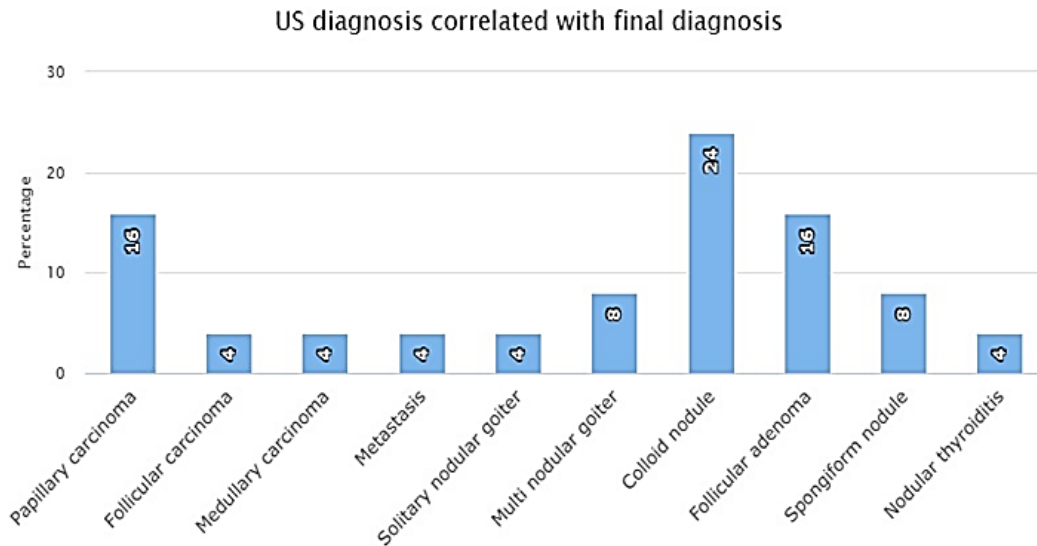


Fig (2) shows US diagnosis correlated with final diagnosis

Discussion

This study was carried on patients who were referred from outpatient clinics to the radiology department of Met Gamer oncology center. A total number of 50 patient included in this study with incidental thyroid nodules on different radiological imaging's like MRI, CT and US that performed for assessment other regions not involved the thyroid and these patients underwent ultrasound examination of the thyroid that confirmed the presence of thyroid nodules. In the present study, as regard age, the mean age of study population is 44.7. As regard gender, the number of males were 8 (16% of patients were males), while the number of females were 42 (84% were females). Mean patient age was 41.5 ± 9.65 and 49.3 ± 10.4 years in patients with benign and malignant nodules there was no statistical significant difference between the groups as regards the age, sex, however incidental thyroid nodules tends to be more common in females than males

The role of US in the detection of thyroid nodules has greatly increased, which normally goes unnoticed during routine clinical examination. As stated by the Incidental Thyroid Findings Committee that ITNs can be seen in 20 to 67% of

ultrasound imaging, 25% of chest CT scans, and 18% of CT and MRI scans of the neck (8).

In this study the main symptoms were cough 36% , LNS swelling 20%, chest pain 12%, hoarseness of voice 12%, dyspnea 8% and fever 6% The CT or MRI study should first be evaluated for suspicious features associated with the ITN, including abnormal lymph nodes or signs of local invasion, neither of which is likely in a patient without thyroid-related symptoms. Abnormal lymph nodes are defined as enlarged nodes (9).

From 50 incidental nodules 36 nodules were benign nodules and 12 nodules were primary malignant and 2 nodules metastatic nodules

In a recent years, the high incidence of thyroid nodules has become particularly significant, primarily because of its gradually increasing annual prevalence and the increasing use of ultrasound. (10) Pathologically, most thyroid nodules are benign, with malignancy rate of approximately 5% to 7%. Studies have shown that undifferentiated cancers that lead to a high mortality rate account for 1% to 2% of malignant nodules (11)

The majority of malignant nodules (especially those that are <1 cm) often have

indolent behavior with positive prognoses. Therefore, many researchers have suggested that patients with thyroid nodules receive excessive care, and the significance of ultrasound has been questioned (12)

The term Incidental thyroid nodules are coined due to the presence of newly seen nodules on imaging such as ultrasound, computed tomography, magnetic resonance imaging and the more advanced positron emission tomography. (13)

Ultrasonography is the gold standard for study of thyroid nodules. It can detect small, multiple nodules and also isolate central or lateral neck lymphadenopathies. It provides accurate clarity in dimensions. It also characterizes nodules if suggestive of malignancy by highlighting irregular margins, absence of halo, micro calcifications. Characteristic features that could hint the prevalence of malignancy in a patient's history are previous head and neck irradiation, prevalence of rapid growth, dysphagia, and a family history of endocrine neoplasia or thyroid carcinoma. (13)

In the present study as regard ultrasound finding, we classified type of nodule as Solitary nodule, Multinodule and cystic nodule. Solitary solid nodule represented (64%) of all patients while Solid

Multinodule was 12% of all patients and cystic nodule/s was 24% of all patients

A slight difference was found compared to the study done by (14) where nodules were solitary in 55% and multiple in 45%. However, in a study published 2018, the results indicate that 59.4% of the patients had multiple nodules while 40.6% had single nodules (13). The results of an Italian study (2) in which solitary nodules were found in 48.5% and multiple nodules in 51.5%.

According to the study done in 2018 (13), ten (31.25%) were reported to have solid nodules whereas two (6.25%) of them were having cystic nodules. In contrast to our result, (15) cystic nodules were present in 49.4% and nodules of solid features were 33.6%.

In the present study as regard nodular outline, 18 cases showed regular nodular outline (72%) while irregular or ill-defined outline represented in 7(28%) patients

Ill-defined margins were commonly seen in malignant thyroid nodules which was a specific criterion for differentiating malignant and benign nodules. (16). In **Sudhir et. al.**, (13) study, out of 15 patients, eleven had well-defined margins while ill-defined margins were noted in four patients. According to that study (13),

nodules that lost their smooth border are considered suspicious nodules and need further investigations to confirm the diagnosis.

In the present study, calcification was obtained in 12 cases (52%) which is divided into coarse or macrocalcification (24% of pts.) and microcalcification (28% of pts.) while (48%) of thyroid nodules showed no calcification.

Sudhir et al., (13) study, calcification (dense/ coarse) was a positive finding in the ultrasound of 5 (35%) patients. Coarse calcification can be seen in malignant nodules as stated by **(17)**.

All cases of microcalcifications were seen in papillary carcinoma with 100% specificity **(16)**. Barring a few cases of papillary and medullary carcinoma, majority of the macrocalcifications were seen in benign thyroid nodules (adenomatous nodules) and showed insignificant p-value. It was claimed that partially microcalcifications are the best predictor of malignancy, whereas other features seem less significant **(18)**.

The additional presence of hyper-echoic foci of calcifications within the nodule further increases the likelihood of cancer—approximately three times the cancer risk for micro-calcifications and twice the risk

for coarse calcifications **(19)**. Micro-calcifications have been reported to have specificity of 44–95% for thyroid cancer, and are particularly associated with papillary thyroid cancer. However, the sensitivity of micro-calcifications is low (26–59%). Coarse macro-calcifications are not specific for malignancy, as they commonly occur in multinodular goiters. However, in situations where there is a single nodule containing coarse calcification, the risk of cancer can be as high as 75% **(20)**.

In the present study, as regards Doppler finding and its relation to malignancy confirmed by histopathological examination we found that all cases with malignant thyroid nodules showed increased central vascularity while benign tumors associated with decreased central vascularity.

A malignant nodule can also have an irregular shape with irregular edges **(19)**. Further evaluation of the nodular vascularity should be performed with colour or power Doppler. Malignant lesions tend to demonstrate intra-nodular vascularity. In contrast, benign nodules have a peripheral rim of blood flow. When both intra-nodular and peripheral

vascularity are present, the nodule is indeterminate

Although few studies reported contradictory results thyroid nodules are classified as non-vascular, peripheral vascular, central vascular, and mixed vascular according to the Doppler examination findings. Increased central vascularity is generally accepted as a supporting feature for diagnosis of malignancy in the literature (21, 22)

In our study, we found relationship between central vascularity and malignancy. Previous studies (5, 22, 23), did not find any relationship between intratumoural vascularity and malignancy, which is not consistent with the results of our study. However, other study (24) says that intranodular vascularity is an important predictor of malignancy.

The sensitivity of Doppler US investigation is affected by settings of a wall filter, depth of the nodule and pulse repetition frequency (PRF), by variations of tissue attenuation, patient movement and lack of cooperation, swallowing or breathing motions. Pulsations of adjacent arterial structures may also affect Doppler US investigation. But recent studies suggested that parameters identified by color and spectral Doppler US may be able

to differentiate between malignant and benign nodules (25)

In the present study, the cytological diagnosis of ultrasound-guided fine needle aspiration biopsy of the thyroid was as the following: colloid cyst (24%), papillary carcinoma (20%), follicular adenoma (16%), solitary nodular goiter (24%), multi nodular goiter (8%), medullary carcinoma (4%), and follicular carcinoma (4%).

On US, thyroid nodules are depicted as discrete lesions, as they cause distortion of the homogeneous echo pattern of the thyroid gland. There are various characteristics on US that help to distinguish benign from malignant nodules. However, it is important to emphasize that the size and number of nodules are not reliable factors for disease differentiation. Evidence has shown that nodular size is not predictive of malignancy risk, and that nodular morphology, rather, is the more important criterion (26)

When assessing a thyroid nodule, it is important to note that malignant lesions are rare. The incidence of the disease is 2–4 cases per 100,000 persons per year. The most prevalent form of thyroid cancer is papillary thyroid cancer (75-80%), followed by follicular (10-20%), medullary (3-5%) and anaplastic (1-2%) thyroid

cancers (27). In addition, the number of nodules is not associated with higher risk of cancer. Regardless of nodule quantity, the overall incidence of thyroid cancer is shown to be consistently between 9.2 and 13% after FNAC (28) previous studies mentioned that solitary nodules, hypoechogenicity, irregular and lobulated margin, and micro calcification were significantly associated with malignancy (29, 30, 5) In this study the US diagnosis was correlated with the final diagnosis based on histological examination in 92% of cases, 14 cases 28% were malignant and 32 cases 64% were benign.

From this study, it became clear that US is an important examination tool in evaluation of suspected incidental nodules. In addition to confirming the benign and malignant nodules US can help define site, size, and extent, number of nodules, echogenicity, calcification, margin, component and vascular involvement.

Conclusion

US is a valuable tool in assessment of incidentally detected thyroid nodules in others imaging features as it can show specific morphologic pattern in differentiating benign form malignant nodules. Ultrasonography can shorten the

diagnosis time and reduce the burden on physicians. US diagnosis was correlated with the final diagnosis based on histological examination in most cases.

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