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Original article

Diagnostic accuracy of sonography in assessment of thyroid masses in comparison with pathology

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Abstract: A thyroid nodule is a solid or cystic lump on the thyroid gland, which involves in the occurrences of various thyroid carcinomas with a notable clinical importance. The present study aimed to observe the diagnostic accuracy of ultrasound (US) in the assessment of thyroid masses compared to pathologic findings. This analytical, epidemiologic study was conducted on 307 patients that were referred to the radiology unit between November 2013 and March 2014 for fine needle aspiration (FNA) of suspected thyroid nodules. There was a significant correlation between echogenicity and pathologic results, which mean more hyper-echogenicity leads to more benign condition (P=0.004). There was no significant correlation between the calcification and the marginal appearance with pathologic results (P=0.270, P=0.860, respectively). There was a significant correlation between the length and width with pathologic results, which mean the shorter length and width lead to a more benign condition (P=0.015, P=0.040, respectively). Besides, there was no significant correlation between vascularity or the age with pathologic results (P=0.450, P=0.930, respectively). This study showed that US could give an incremental value to differentiate benign and malignancy thyroid nodule. Due to the high specificity and predicted values in the detection of benign cases, ultrasound findings can help to favor invasive procedures or follow up of thyroid nodules.

Keywords: thyroid nodules, fine needle aspiration, ultrasonography, pathology

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Introduction

A thyroid nodule is a solid or cystic lump on the thyroid gland. Thyroid nodule may be involved in various thyroid carcinomas with a noteworthy clinical importance [1]. The prevalence of thyroid nodules increased in an age-dependent manner, expanding to over 50% of the world's population [2]; while, further examination by ultrasonography (US) will detect additional nodules in 50% of people with solitary nodules detected by experienced physicians [3]. Biopsy examinations using fine needle aspiration (FNA) proved that around 5% of all nodules are cancerous [4]. Some studies show that 30 to 50% of the asymptomatic population will have at least one thyroid nodule found incidentally on US, which about 5-11% and even up to 30% of them can be malignant [5, 6].

US is the most broadly performed procedure in the thyroid gland screening. It has easy performance, cost effectiveness and sensitivity in determining the size and number of nodules. However, the great question is the role of ultrasonography in triage of thyroid nodules.

Many reports suggested a substantial overlap between the sonography findings in benign and malignant thyroid nodules, which such information may interpret as the vague concept of US in the detection of malignant nodules [7, 8]. So, different range of sensitivity and specificity of US for detecting malignant thyroid nodules are reported in various studies. The sensitivity and specificity of US in detecting palpable malignant thyroid tumors ranged from 80% to 100% and from 40% to 91%, respectively.

However, assessing the accuracy of US diagnosis of non-palpable benign and malignant nodules of the thyroid is promising and considering diverse findings from various studies, the present study aimed to observe the diagnostic accuracy of US in assessment of thyroid masses compared to pathologic findings.

Material and Methods

Study Design and Population

This analytical, epidemiologic study was conducted on 307 patients that were referred to the radiology unit between November 2013 and March 2014 for evaluation of suspected thyroid nodular disease. Then eventually their cytologic specimens (collected by FNA or surgery), were studied. The study was approved by the Ethical Committee of Ahvaz Jundishapur University of Medical sciences, and all patients signed the informed consent prior to enrollment.

Inclusion criteria: Patients with US detectable thyroid nodules in presence of normal levels of FT3, FT4, TSH, and candidate to FNA or surgery .

Exclusion criteria: History of previous surgery.

Table 1. Baseline characteristics of studied group (n=307)

Baseline characteristics	*Number*	*Percentage*
Echogenicity		
• Hypo	101	32.9
• Iso	10	3.3
• Hyper	196	63.8
Calcification		
• Micro	26	8.5
• Coarse	2	0.7
• Non	279	90.8
Margin appearance		
• Specified	303	98.7
• Unknown	4	1.3
Length, cm		
• 1 – 10	5	18.6
• 11 – 20	157	51.1
• 21 – 30	58	18.9
• > 30	35	11.4
Width, cm		
• 1 -10	140	45.6
• 11 – 20	120	39.1
• 21 – 30	39	12.7
• > 30	8	2.6
Vascularity		
• Decreased	52	16.9
• Normal	245	79.8
• Increased	10	3.3
Age, years		
• 20-29	29	9.4
• 30-39	102	33.2
• 40-49	100	32.6
• 50-59	59	19.2
• >60	17	5.5
Pathologic report		
• Benign	287	93.5
• Malignant	12	3.9
• Unknown	8	2.6

Methods

The US findings and the final report, including benign or malignant nodule diagnosis were recorded. If there were indications for Thyroid US examination, patients were undergone FNA (US-guided FNA) or surgical treatment. Then, FNA results were compared with US findings and lastly sensitivity, specificity, positive predictive value and negative predicted value and accuracy were calculated .US findings were indicative for malignancy (marginal hyper-echogenicity, disappearing micro-calcifications, size of more than 10 mm, and vascularization of the nodule). For each nodule, sonographic images were reviewed by three radiology experts, and US characteristics were recorded. For each nodule, the following sonography characteristics were recorded: size, parenchymal composition, echogenicity, and marginal appearance. Size was recorded in three orthogonal dimensions. US images were acquired using a digital US imaging system Phillips HDI 5000 with a 12 MHz linear transducer in the radiology department of Golestan hospital in Ahvaz, Iran.

The variables of interest were assessed according to the Phuttharak et al. protocol [9]. In brief, echogenicity of the thyroid nodule was measured by comparing echogenicity of the thyroid parenchyma and cervical muscle, and was classified as markedly hypoechoic, showing fairly more hypoechoic than adjacent cervical muscle, hypoechoic, showing relatively more hypoechoic than normal thyroid parenchyma, isoechoic, showing isoechoic to normal thyroid parenchyma, or hyperechoic, showing relatively more hyperechoic than adjacent normal thyroid parenchyma. Thyroid nodular vascularity was assessed and classified based on the standardized ultrasound report for thyroid nodules [10].

Internal content of the nodule was categorized according to the ratio of cystic to solid portion in the nodule and was classified as predominantly solid, <50% cystic or predominantly cystic, ≥50% cystic. A spongiform appearance was defined as the aggregation of multiple micro-cystic components in more than 50% of the volume of the nodule. Margin of the nodule was categorized as well-defined margin or indistinct margin. Discontinuity of peripheral halo sign of the nodule was also evaluated.

Calcification was observed regarding the size of the nodule and was classified as microcalcification, tiny, punctuate echogenic foci of 1 mm or less either with or without posterior acoustic shadowing or macrocalcification, and punctuate echogenic foci larger than 1 mm in size.

Statistical Analysis

Statistical analysis was done by SPSS 17.0. Sensitivity (Se), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), and accuracy were estimated using following formulas (abbreviations: TP, true positive; FN, false negative; TN, true negative; FP, false positive).

$$Se = [TP / (TP + FN)] \times 100\%$$
$$Sp = [TN / (TN + FP)] \times 100\%$$
$$PPV = [TP / (TP + FP)] \times 100\%$$
$$NPV = [TN / (TN + FN)] \times 100\%$$
$$Accuracy = [(TP + TN) / (Positive + Negative)] \times 100\%$$

The sensitivity, specificity, positive and negative predictive values, accuracy, and likelihood ratios (95% confidence intervals [CI]) of US, and pathology were determined for each site of involvement. Parametric and nonparametric continuous variables were compared using Student's t-test, and categorical variables were compared using the chi-square test, Fisher's exact test, the MacNemar test, or the Z statistic as appropriate. P values <0.05 were considered statistically significant.

Results

Baseline characteristics of study group have been given in *Table* 1.

There was a significant correlation between echogenicity and pathologic results, which mean more hyper-echogenicity leads to more benign condition (P=0.004). There was no significant correlation between the type of calcification and pathologic results (P=0.270). Also there was no significant correlation between the marginal appearance and pathologic results (P=0.860). There was a significant correlation between the length and width with pathologic results, which mean the shorter length and width lead to a more benign condition (P=0.015, P=0.040, respectively). Besides, there was no significant correlation between vascularity and the age with pathologic results (P=0.450, P=0.930, respectively). Accuracy in evaluation benign and malignant involvement of thyroid nodules in our study was 72.96% and 93.49% respectively (*Table* 2).

Table 2. Statistical results of ultrasonography and pathology in detection of benign and malignant thyroid nodules

Diagnosis	*Benign*	*Malignant*
True positive, no	204	12
True negative, no	20	275
False positive, no	0	20
False negative, no	83	0
Sensitivity, %	71.08	100
Specificity, %	100	93.22
Positive predictive value, %	100	37.50
Negative predictive value, %	19.42	100
Accuracy, %	72.96	93.49

Discussion

Assessing the accuracy of US diagnosis of non-palpable benign and malignant nodules of the thyroid may lead promising findings, so the present study which aimed to observe the diagnostic accuracy US in assessment of thyroid masses in comparison with pathology, showed the accuracy of US in diagnosis benign and malignant thyroid nodules is acceptable.

Recently, Ghajarzadeh et al. determined the diagnostic accuracy of US in detecting malignant thyroid nodules, through a systematic review and meta-analysis of all available evidence. They claimed that US can be considered as a reliable screening tool for characterizing thyroid nodules, and detection of benign pathology in almost all cases, thus can be used to exclude many patients from further invasive assessments [11]. Zhuo et al. assessed the performance of acoustic radiation force impulse (ARFI) imaging to differentiate benign from malignant thyroid nodules in 182 patients who needed thyroid surgery. They reported that ARFI imaging may be helpful to differentiate benign thyroid nodules from malignant, and the selecting measurement position is important, as well as it has worthy diagnostic value in clinical applications [12]. Campanella et al. conducted a study to quantify the risk of malignancy of thyroid nodules using US by conducting a systematic review and meta-analysis of all available studies. They showed the highest risk of malignancy was found for nodule height greater than width, and microcalcifications [13]. Kim et al. investigated the benign thyroid nodules at initial fine-needle aspiration biopsy (FNAB) to determine the percentage of nodules that increased in volume by more than 50% as being an indicator of malignancy in concordance with long-term US, and showed that a positive FNAB result for malignancy is significantly more likely in the presence of suspicious US features [14]. Yang et al. explored the values of US in differentially diagnosing benign and malignant thyroid nodules, and showed that US can be used to evaluate the malignancy risk of thyroid nodules and help to make the right decision in clinics [15]. Wu et al. evaluated the diagnostic utility of conventional US in differentiating degenerating cystic thyroid nodules mimicking malignancy from thyroid carcinoma, and showed that US contributes to increasing the performance in differential diagnosis of thyroid nodule and malignancy [16].

Phuttharak et al. compared diagnostic performance of US and US plus color Doppler ultrasound in predicting malignancy of thyroid nodules by using tissue diagnosis as the reference standard, and reported that combination method findings improve the diagnosis of malignancy in thyroid nodules [9]. In contrast, Batawil et al. evaluated the predictive value of ultrasonography and the frequency of malignancy in patients who had indeterminate thyroid nodules, and showed that limited accuracy of US risk factors, surgical intervention is the treatment of choice for thyroid nodules [17]. Our result showed that US considerably can help in deterring benign thyroid nodule, and may provide more promising results in case of malignant thyroid nodules.

Conclusion

This study showed that due to the high incidence of thyroid nodules and the availability of noninvasive procedures such as US, this method can play a key role in differentiating benign from malignant thyroid nodules. Therefore, it is better that thyroid nodules, which are suspected to malignancy in the ultrasound undergo FNA-guided US. You must bear in mind that thyroid nodules which are suspected of malignancy in the ultrasound include, low echogenicity and nodule size of more than 10 mm in length and width. Other ultrasound findings such as microcalcifications, vascularity, size of the nodules and the age of the patient paly no major role in determining benign thyroid nodules from malignant.

This study showed that pathology and US have an incremental role in diagnosis of benign thyroid nodules from malignant. According to the high specificity and positive predictive value of US in diagnosing benign nodules and high accuracy in the differential diagnosis of malignance thyroid nodules from benign, merging these two methods (US and Pathology) in patients with thyroid nodules helps physicians in making decisions about treatment of the nodules.

Conflict of interest: none declared.

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