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The Diagnostic Value of Color Doppler Ultrasound and Grey Scale Sonography in Predicting the Malignancy of Thyroid Nodules

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Abstract

Retrospective study was done at KAUH to determine the sonographic characteristics in predicting the malignancy of thyroid nodules. The sample was 120 patients consisting of 70 benign nodules and 50 malignant nodules. Out of 120 patients, 106 (88.3%) female and 14 (11.7%) male patients. Out of 106 female patients, 64 (91.45) had benign and 42 had malignant thyroid nodules. Out of 14 (11.7) male patients, 6 had benign and 8 had malignant thyroid nodules. The youngest patient in our study was 31 years and the oldest patient was 76 years. The common range of patients age was ≥ 60 years and consisting of twenty (28.6%) benign thyroid nodules and fourteen (28%) malignant thyroid nodules. The majority of patients' age group with malignant thyroid nodules were between 50 - 60 years and consisting of twenty (40%) malignant nodules. In our study, according to the result of gray scale and color Doppler ultrasonography, hypo-echogenicity, solid echo structure, micro-calcification and intra-nodular vascularity were the significant characteristics of malignancy in nodules with sensitivity (72%, 74%, 48% and 88% respectively), specificity (66%, 63%, 94% and 69% respectively), PPV (60%, 59%, 86% and 67% respectively) and NPV (77%, 77%, 72% and 89% respectively).

Keywords

Ultrasound, Thyroid Nodules, Malignant, Color Doppler, Fine Needle Aspiration

1. Introduction

Thyroid gland is located just below the Adam's apple and sits at the front of neck

region. The thyroid gland is a significant part of the endocrine system. The change of the secretion of thyroid hormone leads to hyperthyroidism (high function) or hypothyroidism (low function) and will influence the function of thyroid gland. There are many types of thyroid diseases such as Graves' disease, Colloid nodules, Thyroid cysts, inflammatory nodules, Multinodular goiter, Hyper functioning thyroid nodules, Thyroid cancer [1]. The most common thyroid abnormality are the thyroid nodules. It is abnormal lesion that forms a lump within thyroid gland and it can be either malignant or benign nodules [2]. The prevalence of the nodules is depending on many different influences like age, gender, diet, iodine deficiency, and through therapeutic and environmental radiation exposure. The evaluation of thyroid nodule includes physical examination, imaging techniques and fine needle aspiration (FNA) [3]. During physical examination, thyroid nodules are detected by palpation. The sensitivity of the palpation method is 10% - 41% and become more sensitive with increasing nodule size. The fact that 89% of the palpated nodules are 10 mm and above in size indicates that it is difficult to identify nodules smaller than 10 mm with physical examination. However, solid thyroid nodules as small as 3 mm in diameter and cystic nodules as small as 2 mm can be readily detected using high frequency ultrasonography (USG) [4]. The most sensitive imaging modality available for examination of the thyroid gland and associated abnormalities is the high-resolution ultrasonography (USG) [5]. Ultrasound scanning is non-invasive, safe, costing low, lacking the ionizing radiation so causing no harm on the body organs and fast giving immediate information. Further, real time ultrasound imaging helps to guide diagnostic procedures (FNA cytology/biopsy) in cases of thyroid disease [6]. Fine needle aspiration cytology (FNAC) is the best single test in diagnosis malignant thyroid nodules and it acts as a gold standard [7]. It is a type of biopsy procedure that inserts a thin needle into the abnormal nodules and the sample collected to make an accurate differentiation between malignant and benign nodules [8]. However, because it is an invasive test, scientists searched for a less invasive method and they found that thyroid ultrasonography (US) has the ability to differentiate between solid and cystic nodules by the echo pattern, and determine if there is any calcification with Grey Scale Sonography technique, and evaluation the vascularity of thyroid nodule with Color flow-Doppler (CFD) sonography technique [9]. The combination of grey scale ultrasonography and color Doppler ultrasound plays an important role in the diagnosis of many thyroid diseases and in the selection of appropriate surgical/non-surgical treatments these diseases. Color Doppler ultrasound provides a color display of the blood flow. It permits for evaluation of vascularity in the thyroid nodules (intra-nodular, peri-nodular or no vascularity). The color Doppler could be an effective tool in the diagnosis of thyroid nodules [10]. This study attempted to assess the characteristics of blood flow within the thyroid nodules and gray-scale ultrasound characterization of these nodules to predict a malignant nodules by using the result of FNA as the reference standard.

2. Materials and Method

2.1. Patients

This study is a retrospective study and based on a medical records of patients with thyroid nodule and requested thyroid ultrasound, color Doppler and fine needle aspiration at the Diagnostic Radiology Department of (KAUH), Jeddah, Saudi Arabia, in the period of 2016-2018.

2.2. Color Doppler Ultrasound

Thyroid ultrasound was performed by the technologist with a high-resolution ultrasound instrument equipped with a high frequency (7.5 - 10 MHz) linear array transducer and Philips ultrasound machine [11]. First, an ethical approval was obtained from the (KAUH). Second, the data was collected from the medical records of patients who performed thyroid ultrasound, color Doppler and fine needle aspiration (FNA) [12].

2.3. Biopsy Method and Pathologic Correlation

A sample of 120 patients with thyroid nodules are used from in-patients and out-patients clinic of KAUH. Patient gender, age, the nodule size, echogenicity, calcification, vascularity and the type of thyroid nodule (malignant or benign) from the fine needle aspiration are collected. Then, on Statistical Package for the Social Sciences (SPSS) the data will be classified by the nodule echogenicity, calcification, vascularity and type of thyroid nodule. Then we will describe and analyze the correlation between the benign and malignant thyroid nodules and the sonographic features of each type of these thyroid nodules. Finally, the sonographic criteria of malignant thyroid nodules will determine.

2.4. Results and Analyses

Table 1 shows that 106 patients with thyroid nodules were female patients, 14 patients were male patients. Female patients had benign nodules 64 (91.4%), male patients had benign nodules 6 (8.6%). For malignant, female 42 (84.0%) and male 8 (16.0%).

Table 2 shows that the maximum age range was ≥ 60 years which contains 20 patents with benign nodules and 14 patients with malignant nodules. The lowest age group was < 40 which contains 18 patients with benign nodules and 6 patients with malignant nodules.

Table 3 shows that hypoechoic echogenicity was common in malignant nodules (72%) and isoechoic was common in benign nodules (57.1%). Hyperechoic were rare in both benign and malignant nodules (8.6% and 8% respectively).

Table 4 shows that most of malignant nodules were solid nodules (74%) and most of benign nodules were mixed echo structure (48.6%). The lowest appearance of echo structure in malignant and benign nodules was cystic which is 0% in malignant nodules.

Table 1. Gender distribution of malignant and benign thyroid nodules.

Variables		FNA				p value
		Benign N = 70		Malignant N = 50		
		No	%	No	%	
Gender	F	64	91.4%	42	84.0%	N/A
	M	6	8.6%	8	16.0%	

Table 2. Age distribution of malignant and benign thyroid nodules.

Variables		FNA				p value
		Benign N = 70		Malignant N = 50		
		No	%	No	%	
Age	>40	18	25.7%	6	12.0%	0.01
	40 - 49	22	31.4%	10	20.0%	
	50 - 60	10	14.3%	20	40.0%	
	≤60	20	28.6%	14	28.0%	

Table 3. Echogenicity of thyroid nodules.

Variables		FNA				p value
		Benign N = 70		Malignant N = 50		
		No	%	No	%	
Echogenicity	Hyperechoic	6	8.6%	4	8.0%	0.01
	Hypoechoic	24	34.3%	36	72.0%	
	Isoechoic	40	57.1%	10	20.0%	

Table 4. Echo structure of thyroid nodules.

variables		FNA				p value
		Benign N = 70		Malignant N = 50		
		No	%	No	%	
Echo structure	Cystic	10	14.3%	0	0%	0.01
	Mixed	34	48.6%	13	26.0%	
	Solid	26	37.1%	37	74.0%	

Table 5 shows that no calcification was common in benign nodules (77.1%) and micro-calcification was common in malignant nodules (48%). Macro-calcification was rare in both benign and malignant nodules (17.1% and 12% respectively).

Table 6 shows vascularity of thyroid nodules. Benign Absent are 36 (51.4%) and intra nodular 22 (31.4%) per nodular 12 (17.1%), Malignant Absent are 2 (4.0%) and intra nodular 44 (88.0%) per nodular 4 (8.0%).

Table 7 shows the sonographic criteria of malignant thyroid malignancy in nodules with sensitivity (72%, 74%, 48% and 88% respectively), specificity (66%, 63%, 94% and 69% respectively), PPV (60%, 59%, 86% and 67% respectively) and NPV (77%, 77%, 72% and 89% respectively).

Table 5. Calcification of thyroid nodules.

Variables		FNA				p value
		Benign N = 70		Malignant N = 50		
		No	%	No	%	
Calcification	Macro-calcification	12	17.1%	6	12.0%	0.01
	Micro-calcification	4	5.7%	24	48.0%	
	No calcification	54	77.1%	20	40.0%	

Table 6. Vascularity of thyroid nodules.

variables		FNA				p value
		Benign N = 70		Malignant N = 50		
		No	%	No	%	
Vascularity	Absent	36	51.4%	2	4.0%	0.01
	Intranodular	22	31.4%	44	88.0%	
	Per nodular	12	17.1%	4	8.0%	

Table 7. The sonographic criteria of malignant thyroid nodules.

		Sensitivity (%)	Specificity (%)	PPV	NPV	p value
Echogenicity	Hypoechoic	72% (36/50)	66% (46/70)	60%	77%	0.01
Vascularity	Intra-nodular	88% (44/50)	69% (48/70)	67%	89%	0.01
Calcification	Micro-calcification	48% (24/50)	94% (66/70)	86%	72%	0.01
Echo structure	Solid	74% (37/50)	63% (44/70)	59%	77%	0.01

3. Discussion

In this study, real time B-mode and color Doppler ultrasound were preform to determine the sonographic characteristics in predicting the malignancy of thyroid nodules. The sample was 120 patients consisting of 70 benign nodules and 50 malignant nodules. Out of 120 patients, 106 (88.3%) female and 14 (11.7%) male patients. Out of 106 female patients, 64 (91.45) had benign and 42 had malignant thyroid nodules. Out of 14 (11.7) male patients, 6 had benign and 8 had malignant thyroid nodules. The youngest patient in our study was 31 years and the oldest patient was 76 years. The common range of patients age was ≥ 60 years and consisting of twenty (28.6%) benign thyroid nodules and fourteen (28%) malignant thyroid nodules. The majority patients age group with malignant thyroid nodules were between 50 - 60 years and consisting of twenty (40%) malignant nodules. One unanticipated finding was that size of thyroid nodules cannot differentiate between benign and malignant nodules; therefore, it is not a characteristic of malignant thyroid nodules in our result. Out of 120 patients with thyroid nodules, 60 patients with hypoechoic thyroid nodules, thirty-six were malignant nodules, which acts (72%) of the total number of malignant nodules, twenty-four were benign nodules and it acts (34.3%) of the total benign nodules. These results showing that hypoechoic nodules are suggestive of malignant nodules, which is common incidence in malignant nodules comparing to benign nodules. Hyperechoic echogenicity was in ten patients, six were benign and four were malignant which is rare in both malignant and benign nodules. According to the echo structure, sixty-three patients with solid thyroid nodules, were malignant nodules and it is showing (74%) of the total malignant nodules, twenty-six were benign and it is (37.1%) of the total benign nodules. Therefore, solid thyroid nodules a suggestive characteristic of malignant thyroid nodules. Cystic echo structures were common in benign nodules comparing with malignant nodules, ten benign nodules were cystic and no malignant nodule was cystic in echo structure. According to the calcifications, seventy-four patients with no calcification in both types of thyroid nodules, fifty-four were benign and it acts (77.1%) of the total number of benign nodules, twenty were malignant which is (40%) of malignant nodules. Micro calcification was common in malignant nodules comparing to benign nodules, twenty-four malignant nodules were with micro-calcification (48%), and four were benign and it acts (5.7%) of all benign nodules. Therefore, according to this result micro-calcification is a sonographic characteristic of malignant nodules. According to the color Doppler result, absent and peri-nodular of blood flow were common in benign nodules comparing to malignant nodules which act (68.5%) of the total benign nodules comparing to (12%) in malignant nodules. Intra nodular blood flow was very common in malignant nodules which act forty-four (88%) of malignant nodules comparing to twenty-two (31.4%) of benign nodules. In our study, according to the result of gray scale and color Doppler ultrasonography, hypo-echogenicity, solid echo structure, micro-calcification and intra-nodular vascularity were a

significant characteristics of malignancy in nodules with sensitivity (72%, 74%, 48% and 88% respectively), specificity (66%, 63%, 94% and 69% respectively), PPV (60%, 59%, 86% and 67% respectively) and NPV (77%, 77%, 72% and 89% respectively). These findings were in agreement with Manoj's (2016) findings that showed these characteristics are common for malignant nodules. The micro-calcification had the least sensitivity (48%) and most specificity (94%)

4. Conclusion

According to our results of gray scale and color Doppler ultrasonography, hypo-echogenicity, solid echo structure, micro-calcification and intra-nodular vascularity were the significant characteristics of malignancy in nodules with sensitivity (72%, 74%, 48% and 88% respectively), specificity (66%, 63%, 94% and 69% respectively), PPV (60%, 59%, 86% and 67% respectively) and NPV (77%, 77%, 72% and 89% respectively). These findings were in agreement with Manoj's (2016) findings that showed these characteristics are common for malignant nodules. The micro-calcification had the least sensitivity (48%) and most specificity (94%), the Gray scale combined with Color Doppler US are valuable methods for evaluating thyroid nodules and can be used as a Para-clinical method to assess the risk of malignancy in the patient with thyroid nodules.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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