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Evaluation of the Role of Thyroid Scintigraphy and Doppler Ultrasonography in the differential Diagnosis of Thyrotoxicosis

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ABSTRACT:
Correlatebetween the results of thyroid function test, ultrasonography and thyroid scintigraphy using GE introduces Discovery NM-CT 670 pro and Q.Merix at nuclear medicine department and GE Logiq E9 equipment at ultrasound department at King Saud Medial Center (KSMC) in Saudi Arabia. The total number of patients was 144 where the males was 33 with percent 22.9 and the number of females was 111 with percent 77.1
Statistical parameters for measurement presented as mean, standard deviation, minimum and maximum for TSH, T4, right lobe volume, left lobe volume and thyroid uptake. For TSH the mean ± STD was 0.99 ± 2.46, for T4 was 32.22 ± 29.18, for right lobe volume and left lobe volume was 15.97 ± 14.28 and 12.77 ± 11.89 for thyroid uptake was 7.73 ± 9.35.
Correlate between the ultrasound finding with background, were the patients with nodule with mixed echogenicity was 45 patients distributed with different background as follow: 18 normal patients, 4 patients with increase, 2 patients moderately low, 4 mildly low and 17 patients low. While the normal finding with 32 patients divided as follow: 9 patients normal, 2 patient increase, one patient moderately low, 2 mildly low and 18 patients low. Also, correlation between the nuclear medicine finding with background, where the patients with graves' disease was 60 patients when correlate with background found that: 2 normal patients, one patient increase, 3 patients moderately low, 8 patients mildly low and 46 patients with low. While multinodular goiter found with 24 patients divided to: 10 normal patients, 3 increase , one patient moderately low, 2 patients mildly low, and 8 patients low.
Analysis of variance between the thyroid uptake with right and left lobe volume, were the p,value showed there is no significant difference between the right and left lobe with thyroid uptake were the p.value was 0.965 and 0.938 respectively.
Key wards: Thyroid Hormone , Thyroid Gland, Thyroid ScintigraphyDoppler Ultrasonography

I. INTRODUCTION:

Imaging has long been established as an essential element in the workup of clinically suspected lesions of the thyroid gland. Ultrasonography (US) is the modality of choice for initial characterization of a thyroid nodule [1]. Although thyroid nodules may be detected at computed tomography (CT) and magnetic resonance (MR) imaging, these modalities are not useful for characterization of a nodule.

Positron emission tomography (PET) may occasionally help identify thyroid nodules, but it is considered by some authors to have limited utility in differentiating benign from malignant lesions [2-4]. There are several recently published guidelines for determining whether a nodule should undergo US-guided fine-needle aspiration biopsy (FNAB) on the basis of its US and clinical features. These guidelines were published by (among others) the Society of Radiologists in Ultrasound (2005), the American Thyroid Association (2009), the American Association of Clinical Endocrinologists/Association Medici Endocrinology/ European Thyroid Association (2010), and the National Comprehensive Cancer Network (updated in 2013) [5-8].Thyroid gland has the unique ability to take up iodine — an essential component of its hormones. The phenomenon of accumulation of iodine in the thyroid gland allowed for the use of iodine isotopes in the diagnosis of thyroid disease as early as about 70 years ago, although the mechanism of iodine uptake at the molecular level has been carefully examined until the late twentieth century. In 1939, a group of scientists from the University of Berkeley documented the uptake of radioactive iodine in human thyroid for the first time. This gave rise to first therapeutic radioiodine applications in patients with hyperthyroidism and thyroid cancer [9,10]. Nowadays, we know that the uptake of iodine in the thyroid gland is attributed to the sodium-iodide symporter (NIS), described in 1993 by Kaminsky et al [11]. The uptake of iodine by the thyroid cells is

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still widely used in the evaluation of thyroid function by means of radioiodine uptake test and thyroid scintigraphy [12].

Ultrasound (US) of the thyroid is well established for a variety of indications and applications. US is the most sensitive imaging test available for the examination of the thyroid gland, to detect and characterize lesions, accurately calculate their dimensions, identify the internal structure and vascularization using color Doppler imaging (CDI) and evaluate diffuse changes

in the thyroid parenchyma. Thyroid US is able to confirm the presence of a thyroid nodule when the physical examination is equivocal and differentiate between thyroid nodules and cervical masses from other origins [13,14].

Various types of thyroid disorders may affect normalfunction of the thyroid glands. For instance, in Graves' disease, thyroid stimulating hormone receptor antibodies (TSHR-Ab) bind thyroid stimulating hormone receptor (TSHR) and activate it, leading to hyper-secretion, hypertrophy, and hyperplasia of the thyroid follicles [15]. One of the features of this interruption may appear in thyroid blood flow [16-20]. Therefore, evaluation of this parameter may be an indicator in assessment of thyroid gland function.

Application of diagnostic nuclear medicine techniques for this purpose-thyroid scintigraphyis associated with favorable sensitivity and specificity which provides images of the vascularity of "cold" thyroid nodules, which can be used to distinguish neoplastic from non-neoplastic ones [21-24]. Because of the similarity of the 99mTcO4 with iodine (with respect to the molecular size), thyroid uptake of 99mTc can be used to assess thyroid function [25].So, the aim of this study to correlate between the results of thyroid function test, ultrasonography and thyroid scintigraphy.

II. METHODOLOGY:

The study was conducted in Saudi Arabia at King Saud Medial Center (KSMC), The data was collected from Picture and Communication System (PACS) of nuclear medicine department with different age, gender and thyroid abnormalities. This study was conducted from 2017-2021.

Machine: Procedure was done by GE introduces Discovery NM-CT 670 pro and Q.Merix at nuclear medicine department and GE Logiq E9 equipment at ultrasound department.

Techniques: A thyroid sonogram was performed with a high-frequency linear array transducer having a short focal zone (1 to 4 cm). The patient was examined in supine position, with the neck extended and pillow under shoulder. Images are obtained in both the sagittal and transverse planes of each lobe and of the isthmus. Normal thyroid tissue is homogeneously fine textured with medium to high levels of echogenicity. The echogenicity is usually greater than the normal neck muscles. Each adult pear-shaped lobe measures approximately 4 to 6 cm in length, 2 to 3 cm in width, and 1 to 2 cm in thickness, with the right lobe typically being the largest. Then the thyroid volume can be calculated using the following formula: length × width × thickness × 0.529. Moreover, each thyroid lobe should be evaluated using color Doppler because the amount of vascularity may be evident of disease.

Then the patient was referred for thyroid uptake and scan, it was performed by preparing patient well as certain foods and medications interfere with radiotracer uptake in the thyroid gland. Firstly, the radiotracer (Technitium 99mTC) which emits gamma radiation was prepared and pulls it into the syringe, the scan was done for full syringe and the counts were collected, then the patient was injected intravenously by radiotracer and the empty syringe was scan again, 20-30 min after radiotracer administration the patient lied down on the movable examination table, and the gamma camera took serial images of the thyroid gland from different angles. The images were analyzed and the counts were collected to calculate the percentage of thyroid uptake using below equation:

$$\text{uptake\%} = \frac{\text{Neck Counts} - \text{Thigh Counts}}{(\text{Admin. counts X decay factor}) - \text{Background Counts}} X100$$

The normal values of thyroid uptake of radiotracer was (0.5 – 2)% The thyroid gland can uptake more or less than normal. More than normal uptake of radioactive iodine by the thyroid gland indicates hyperactive thyroid and less than normal uptake infers hypoactive thyroid gland, or interference with the uptake.

III. RESULTS:

Correlate between the results of thyroid function test, ultrasonography and thyroid scintigraphy at ultrasound department at King Saud Medial Center (KSMC) in Saudi Arabia. The total number of patients and the data presented in tables as shown below:

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Table 1. show descriptive statistic for all variables:

	Mean	Std. Dev	Minimum	Maximum
TSH	.9949	2.46390	.00	18.00
T4	32.2226	29.17742	2.27	228.04
RT lobe volume	15.976	14.2860	.0	87.0
Lt lobe volume	12.776	11.8913	.0	66.4
thyroid uptake	7.732	9.3592	.0	39.8

Table 2. Show group statistics for patients according to their gender:

	Gender	Mean	Std. Dev	Std. Error Mean
TSH	Female	.8812	1.89253	.17963
	Male	1.3771	3.82381	.66564
T4	Female	32.4676	31.50799	2.99061
	Male	31.3988	19.76986	3.44149
RT lobe volume	Female	14.955	12.9958	1.2335
	Male	19.410	17.7676	3.0929
Lt lobe volume	Female	11.356	9.9740	.9467
	Male	17.555	16.1052	2.8035
thyroid uptake	Female	7.432	9.2197	.8751
	Male	8.742	9.8931	1.7222

Table 3. show frequency distribution for nuclear medicine and ultrasound findings:

NM finding	Frequency	Percent	**US finding**	Frequency	Percent
Normal	11	7.6	Normal	32	22.2
multinodular goiter	24	16.7	Cyst	4	2.8
graves disease	60	41.7	Thyroiditis	9	6.3
autonomous toxic nodule	8	5.6	thyrotoxic goiter	5	3.5
hyperthyroidism	3	2.1	Enlargement	14	9.7
hypothyroidism	5	3.5	nodule with mixed echogenicity	45	31.3
nodule	14	9.7	hypoechoic nodule	14	9.7
thyroiditis	5	3.5	hyperechoic nodule	7	4.9
goiter	12	8.3	graves disease	2	1.4
thyroglossal cyst	2	1.4	diffuse heterogenicity	12	8.3
Total	144	100.0	Total	144	100.0

Table 4. show frequency distribution for background and vascularity for all patients:

Background	Frequency	Percent	**vascularity**	Frequency	Percent
Normal	42	29.2	Normal	51	35.4
Increase	13	9.0	increased	92	63.9
moderately low	6	4.2	Low	1	.7
mildly low	12	8.3	Total	144	100.0
low	71	49.3			
Total	144	100.0			

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Table 5. show correlation between the ultrasound finding with background:

US finding * background Crosstabulation

US finding	Background					Total
	Normal	Increase	moderately low	mildly low	low	
Normal	9	2	1	2	18	32
cyst	3	1	0	0	0	4
thyroiditis	3	2	0	1	3	9
thyrotoxic goiter	2	0	2	0	1	5
enlargement	0	1	0	2	11	14
nodule with mixed echogenicity	18	4	2	4	17	45
hypoechoic nodule	4	0	0	2	8	14
hyperechoic nodule	1	3	1	0	2	7
graves' disease	0	0	0	0	2	2
diffuse heterogenicity	2	0	0	1	9	12
Total	42	13	6	12	71	144

Table 6. show correlation between the nuclear medicine finding with background:

NM finding * background Crosstabulation

NM finding	Background					Total
	Normal	Increase	moderately low	mildly low	low	
Normal	10	1	0	0	0	11
multinodular goiter	10	3	1	2	8	24
graves' disease	2	1	3	8	46	60
autonomous toxic nodule	2	0	1	0	5	8
hyperthyroidism	1	0	0	0	2	3
hypothyroidism	0	3	0	0	2	5
nodule	6	3	1	1	3	14
thyroiditis	2	2	0	0	1	5
goiter	7	0	0	1	4	12
thyroglossal cyst	2	0	0	0	0	2
Total	42	13	6	12	71	144

Table 7. show analysis of variance between the thyroid uptake with left and right lobe volume:

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Right lobe volume	Between Groups	17006.013	98	173.531	.641	.965
	Within Groups	12178.792	45	270.640		
	Total	29184.805	143			
Left lobe volume	Between Groups	12112.884	98	123.601	.686	.938
	Within Groups	8107.621	45	180.169		
	Total	20220.504	143			

IV. DISCUSSION:

Statistical parameters for measurement presented as mean, standard deviation, minimum and maximum for TSH, T4, right lobe volume, left lobe volume and thyroid uptake. For TSH the mean ± STD was 0.99 ± 2.46, for T4 was 32.22 ± 29.18, for right lobe volume and left lobe volume was 15.97 ± 14.28 and 12.77 ± 11.89 for thyroid uptake was 7.73 ± 9.35 in table 1.

Table 2. Show group statistics for patients according to their gender. For TSH the mean ± standard deviation for female was 0.88 ± 1.89 and for male was 1.377 ± 3.82, for T4 female was 32.47

± 31.51 and for male was 31.39 ± 19.77, right lobe volume for female was 14.95 ± 12.999 and for male was 19.41 ± 17.77, for left lobe volume for female was 11.35 ± 9.97 and for male was 17.55 ± 16.10, for thyroid uptake for female was 7.43 ± 9.21 and for male was 8.74 ± 9.89.Frequency distribution for nuclear medicine finding showed that the graves' disease was higher number of patients 60 patients with percent 41.7%, then multinodular goiter with 24 patients and 16.7%m while hypo and hyper thyroidism with 5 and 3 patients. For ultrasound finding we found nodule with mixed echogenicity was higher frequency with 45 patients and 31.3% then normal patients with 32 patients and 22.2%, while the patients with graves' disease with lower frequency just 2 patients and 1.4%. as shown in table 3.Table 4. show frequency distribution for background and vascularity for all patients. For background the low background was dominant with 71 patients and 49.3% then normal patients 42 with 29.2%. while the moderate low was lowest frequency with 6 patients and 4.2%. for vascularity the increased come with more patients 92 and 63.9%, then normal with 51 patients and 35.4% while the low with just one patient and 0.7%.

Table 5. show correlation between the ultrasound finding with background, were the patients with nodule with mixed echogenicity was 45 patients distributed with different background as follow: 18 normal patients, 4 patients with increase, 2 patients moderately low, 4 mildly low and 17 patients low. While the normal finding with 32 patients divided as follow: 9 patients normal, 2 patient increase, one patient moderately low, 2 mildly low and 18 patients low.

Table 6. show correlation between the nuclear medicine finding with background, where the patients with graves' disease was 60 patients when correlate with background found that: 2 normal patients, one patient increase, 3 patients moderately low, 8 patients mildly low and 46 patients with low. While multinodular goiter found with 24 patients divided to: 10 normal patients, 3 increase , one patient moderately low, 2 patients mildly low, and 8 patients low.

Analysis of variance between the thyroid uptake with right and left lobe volume, were the p,value showed there is no significant difference between the right and left lobe with thyroid uptake were the p.value was 0.965 and 0.938 respectively as shown in table 7.

V. CONCLUSION:

Correlate between the results of thyroid function test, ultrasonography and thyroid scintigraphy at ultrasound department at King Saud Medial Center (KSMC) in Saudi Arabia. The total number of patients was 144 where the males was 33 with percent 22.9 and the number of females was 111 with percent 77.1.

Statistical parameters for measurement presented as mean, standard deviation, minimum and maximum for TSH, T4, right lobe volume, left lobe volume and thyroid uptake. For TSH the mean ± STD was 0.99 ± 2.46, for T4 was 32.22 ± 29.18, for right lobe volume and left lobe volume was 15.97 ± 14.28 and 12.77 ± 11.89 for thyroid uptake was 7.73 ± 9.35.

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