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Characterization of Thyroid Nodules using Scintigraphy

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ABSTRACT:
Characterization of thyroid nodules using scintigraphy at three centers in Khartoum sate, A total of 200 patientsreferred to the department for thyroid scan from January 2017 to May 2019. The scintigraphy's were all obtained by using Nucline gamma camera computer system (planer and dual head whole body SPECT) with general purpose collimators made in Hungary.
The statistical parameters for all patients were calculated the mean, median, standard deviation, minimum and maximum, for age, body mass index, thyroid size, and thyroid uptake. The mean ± STD for the age 35.62 ± 12.62, BMI 25.48 ± 5.67, for thyroid size and thyroid uptake 27.48 ± 9.91 and 3.48 ± 5.14 respectively.
correlate between BMI and thyroid uptake for all patients, using linear regression equation were the rate of change of BMI decreased by rate 0.1842 for each unit from thyroid uptake. correlate between BMI and thyroid size for all patients, using linear regression equation were the rate of change of BMI decrease with rate 0.0216 for each cm from thyroid size, correlate between thyroid size and thyroid uptake for all patients, using linear regression equation were the rate of change of thyroid size increase with rate 0.3189 for each from thyroid uptake.Using p. value shows that there is no significant difference between the age with thyroid size and thyroid uptake but there is a significant difference between the patience age and body mass index.

Keywords: *thyroid nodules,thyroid size, thyroid uptake,scintigraphy, Nuclear Medicine*

I. INTRODUCTION:

The Thyroid gland is the largest endocrine gland in the human body. It is located in the neck anterior to the trachea and below the thyroid cartilage. The normal thyroid gland weighs 15 to 20 g in adults. It has two lobes attached to each other by a rim of thyroid tissue known as isthmus in the midline. The pyramidal lobe, a remnant of the thyroglossal duct extends superiorly toward the hyoid bone. It is found almost entirely in patients with autoimmune disease such as Graves's disease or Hashimoto's thyroiditis.The internal carotid arteries and internal jugular veins are located posterolateral to the thyroid lobes, whereas the strap muscles of the neck are located anteriorly. Thyroid is among the most vascular organs gram for gram. A euthyroid gland has a flow rate of about 5 ml/g/min.The thyroid gland plays a critical role in regulating metabolic functions of our body including heart rate, cardiac output, lipid metabolism, heat regulation, and skeletal growth.

The thyroid gland secretes two physiologically important thyroid hormones; L-triodothyronine (T3) and L-thyroxine (T4). While T4 is more abundant in the circulation, T3 is the more important hormone at cellular level. Formation and secretion of T3 and T4 are controlled by Thyroid Stimulation Hormone (TSH) which is produced and secreted from specific cells in the anterior pituitary. TSH is regulated by Thyrotrophin Releasing Hormone (TRH) from the hypothalamus and the negative feedback from increased levels of T3 and T4 levels [1].

There are a wide variety of diseases that affect the thyroid gland and range from hyperplastic to neoplastic, autoimmune, or inflammatory. They can present with functional abnormality or a palpable structural change. Imaging has a key role in diagnosing and characterizing the thyroid finding for management. Imaging is also essential in the management of thyroid cancer. Thyroid nodules are the most common finding in the thyroid gland. The majority of thyroid nodules are benign [2,3]. Initiating workup is costly for the patient and health care system as biopsy is frequently followed by repeat imaging and surgery [4], despite the fact that the majorityof small thyroid cancers are indolent [1,2]. Vaccarellaet al [5] estimated that "overdiagnosis," or identifying cancer that otherwise would be indolent, accounts for 77%of thyroid cancer cases in the United States. The radiology community has proactively addressed issues of thyroid nodule biopsy and unnecessary surgery [6]. The ACR formed committees [7] that published guidance regarding the incidental thyroid nodule detected on imaging [8] and ACR Thyroid Imaging Reporting and Data System (TIRADS) was conceived to aid management of thyroid nodules detected on ultrasound (US) [9].

Nuclear or Radionuclide imaging or Scintigraphy is a diagnostic test where radioisotopes either by themselves or tagged to protein or other molecules are administered intravenously or orally that travel specifically to an organ or tissue and the emitted radiation is captured by specialized scanners known as Gamma Camera to form two-dimensional images. Thyroid scintigraphy therefore images the thyroid gland in vivo. Unlike X-ray (Radiography) where a part of the body is exposed to ionizing radiation in the form of X-rays to form an image, in scintigraphy the internally distributed radioactivity emits gamma radiation that generates images of the body and facilitates whole body imaging whenever required. Radionuclide imaging has been an integral part of thyroid evaluation along with neck ultrasound and plays a key role in the functional evaluation and management of thyroid disease.

131I- Sodium Iodide (NaI)or Radioiodine is a well-established isotope that has been in use for thyroid imaging and uptake studies over the past several decades because of its unique ability of being concentrated by the thyroid gland, and an essential component of thyroid hormones. Owing to its beta emissions, 131I- Sodium Iodide is also used for the treatment of hyperthyroidism and thyroid cancer. 99mTc-Pertechnetate is another isotope emitting gamma rays with a short half-life and similar uptake mechanism based on sodium iodide symporter pump. Together with131I- Sodium Iodide, 99mTc-Pertechnetate forms the main isotopes used for thyroid imaging [10].

The normal thyroid gland demonstrates homogeneous radiotracer uptake. Thyroid scintigraphy plays a rolein the evaluation of a thyroid nodule ina patient who has low serum thyroidstimulating hormone levels. Thyroidscintigraphy with I-123 can identify a

"hot" or hyperfunctioning nodule withradiotracer uptake greater than that ofthe surrounding thyroid. "Hot" nodulesare rarely malignant and do not warrant cytologic analysis. A "warm" oriso-functioning nodule with radiotraceruptake equal to that of the surroundingthyroid, or a "cold" or hypofunctioningnodule with radiotracer uptake less thanthat of the surrounding thyroid, requirefurther evaluation. [11]

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 [12]. The uptake of iodine by the thyroid cells is still widely used in the evaluation of thyroid function by means of radioiodine uptake test and thyroid scintigraphy [13].

Measurement of iodine uptake

Iodine uptake test is mainly used in patients planned for the radioiodine treatment due to hyperthyroidism. The test is performed using a gamma camera or a gamma probe positioned at a certain distance from the patient's neck. In different centres, measurements are performed at various intervals after oral administration of 1–3.7 MBq (30–100 mCi) 131I. Measurements made during the first day are essential for the assessment of iodine accumulation in the thyroid. Therefore, for practical reasons, measurements are often performed 3–6 h and 24 h after administration of the diagnostic dose of 131I. In centres using sophisticated techniques for dosimetry, measurements are performed on several consecutive days [14].

II. METHODOLOGY:

This study was conducted in Nuclear Medicine Department, Radiation and Isotopes Center of Khartoum (RICK), Cancer center in wadmadni, Alnelein Medical Diagnostic Centre. A total of 200 patients 18(8.3%) were males and 180 (84.3%) were females and the average age of the patients studied was 35 years. All patients referred to the department for thyroid scan from January 2017 to May 2019. The scintigraphies were all obtained by using Nucline gamma camera computer system (planer and dual head whole body SPECT) with general purpose collimators made in Hungary. Generator UltraTechneKow ® FM DRN 432999Mo/ 99mTc Generator Composition (elute) 99Mo content < 25 Bq/MBq 99mTc.

Specifications are within the guidelines described by monographs of the U.S.A.and the EuropeanPharmacopoeia PH 5.0 – 7.0 ,10-20 minutes after intravenous injection of 37-111MBq of sodium pertechnetateTc 99m.

Nuclide TM SPIRIT DH-V Variable Angle Dual- Head Digital Gamma Camera for SPECT, whole body and planer imaging , detector Two new developed rectangular jumbo FOV high stability detectors assembled with high optical and mechanical quality, NaI (TI) scintillation crystal size: 585 * 470 mm thickness: 9.5 mm, 15.9 mm or 25 mm pixilated , photomultipliers: 55 pcs of high quantum efficiency PMTs characterized by improved energy resolution, magnetic shielding and long term stability, lead shielding thickness: 12 – 32 mm , detector electronics , A compact , highly integrated , one board easily serviceable construction without tuning potentiometers, computer controlled PMT auto tuning processor for fast PMT gain stabilization and adjustment , computer controlled ODC (Optical Distortion Correction) electronics , High precision summation electronics. Active high voltage bleeder with integrated HV module. Acquisition console. Ergonomic acquisition WS console stands on wheels. Full – digital electronics assembled from the latest "high – tech" elements including fast PCI bus acquisition interface, Intel Pentium 4, 2.26 GHz computer with 64-bit memory handling 512.

III. RESULTS:

Table 1. Show statistical parameters for all patients:

	Mean	Median	STD	Min	Max
Age	35.62	35	12.62	18	75
BMI	25.48	25.6	5.67	12.1	47.6
Thy Size	27.48	25.55	9.91	11.5	73
Thy Uptake	3.48	2	5.14	0.23	34.57

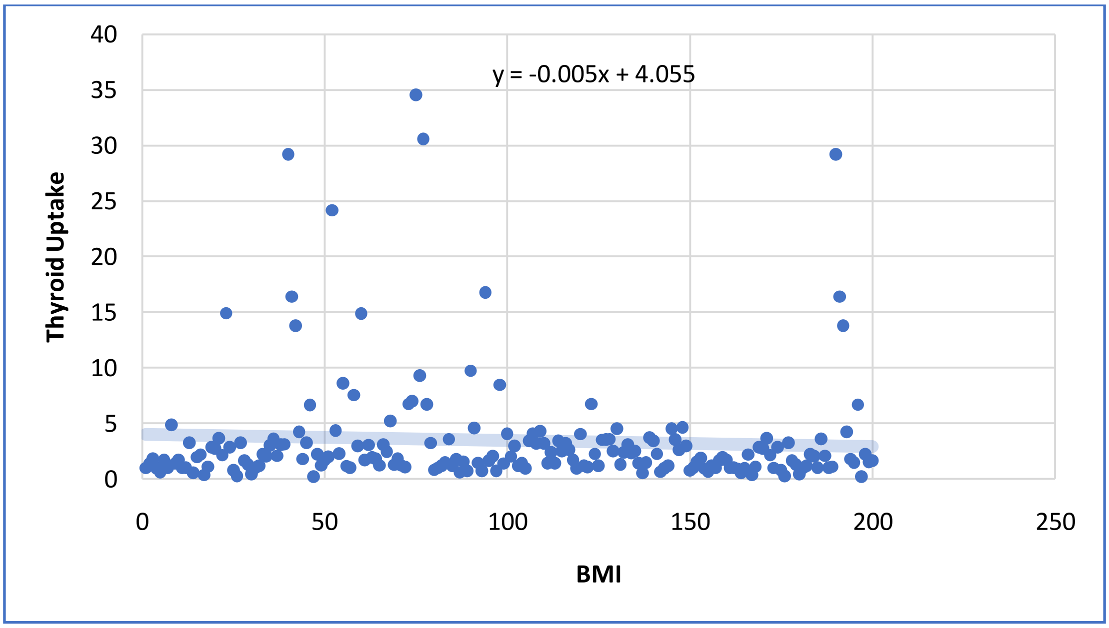

Figure 1. Show correlate between BMI and thyroid uptake for all patients

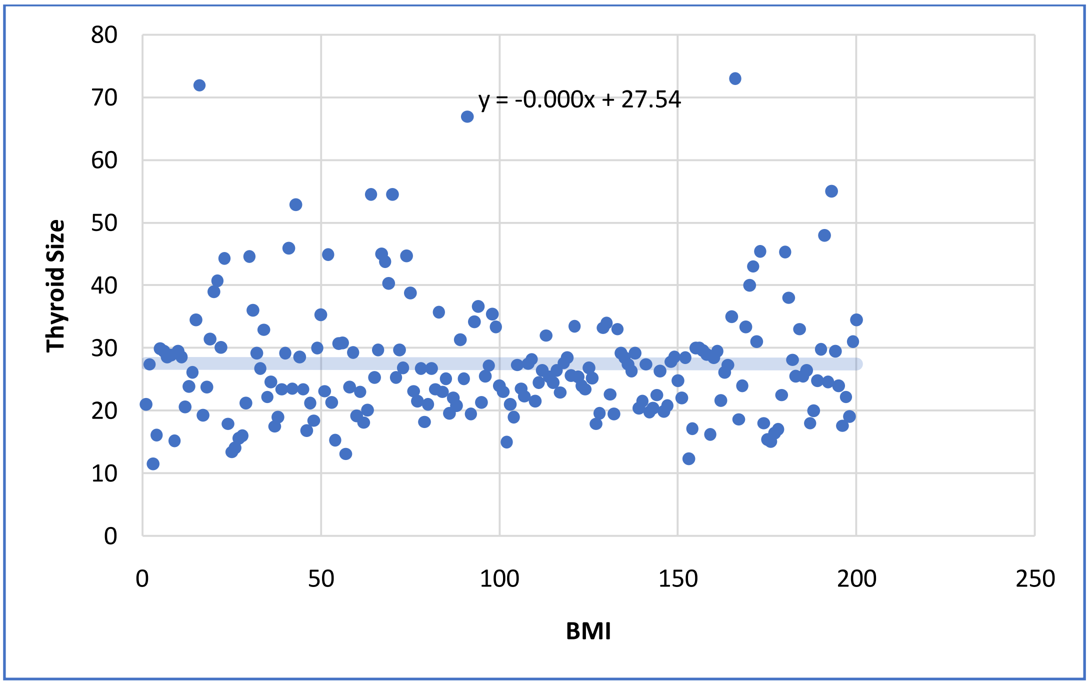

Figure 2. Show correlate between BMI and thyroid size for all patients

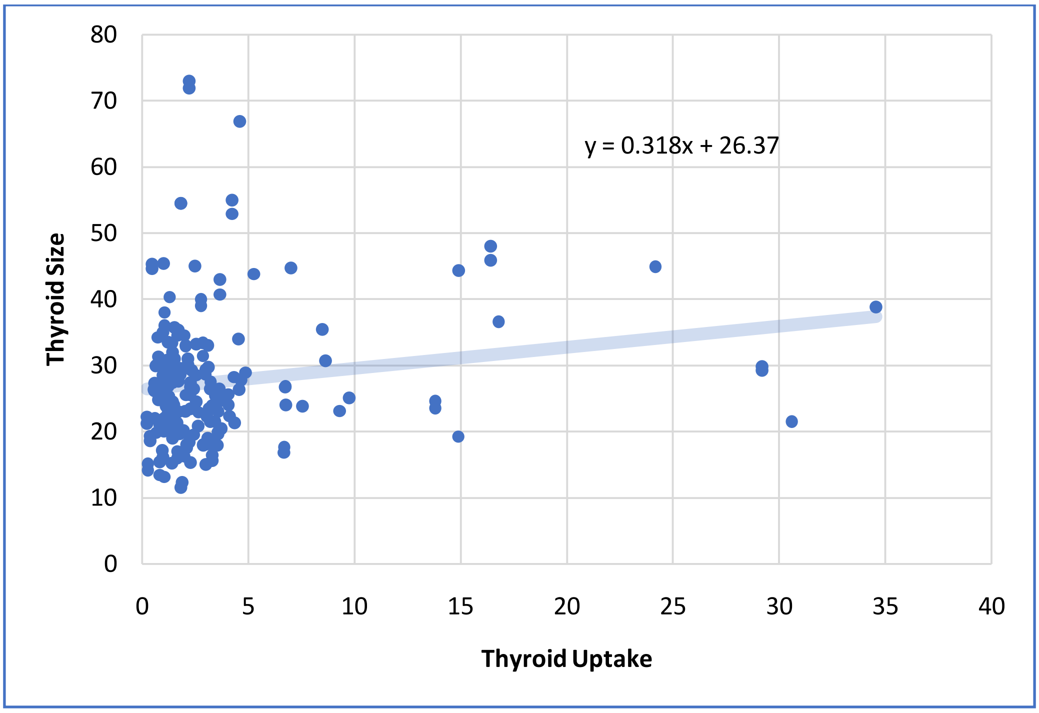

Figure 3. Show correlate between BMI and thyroid size for all patients

Table 2. show analysis of variance test for the patient age with other parameters:

		Sum of Squares	df	Mean Square	F	P. value
BMI	Between Groups	2963.806	43	68.926	3.124	.000
	Within Groups	3442.018	156	22.064		
	Total	6405.824	199			
Thyroid size	Between Groups	4815.552	43	111.990	1.185	.226
	Within Groups	14742.988	156	94.506		
	Total	19558.540	199			
Thyroid uptake	Between Groups	619.846	43	14.415	.485	.997
	Within Groups	4635.477	156	29.715		
	Total	5255.323	199			

IV. DISCUSSION:

Table 1. show statistical parameters for all patients were calculated the mean, median, standard deviation, minimum and maximum, for age, body mass index, thyroid size, and thyroid uptake. The mean ± STD for the age 35.62 ± 12.62, BMI 25.48 ± 5.67, for thyroid size and thyroid uptake 27.48 ± 9.91 and 3.48 ± 5.14 respectively.

Correlate between thyroid uptake with BMI for all patients, using linear regression equation were the rate of change of thyroid uptakedecrease with rate 0.0057 for eachkg/cm2 from body mass index as shown in fig 1. Correlate betweenthyroid size and BMIfor all patients, using linear regression equation were the rate of change of thyroid size decrease with rate 0.0006 for each kg/cm2 forbody mass index as shown in fig 2.

Correlate between thyroid size and thyroid uptake for all patients, using linear regression equation were the rate of change of thyroid size increase with rate 0.3189 for each unit from thyroid uptake.

Table 3. show analysis of variance test between the patients age with different parameters were the p. value shows that there is no significant difference between the age with thyroid size and thyroid uptake but there is a significant difference between the patience age and body mass index.

V. CONCLUSION:

Characterization of thyroid nodules using scintaigraphyat three centers in Khartoum sate, A total of 200 patients 18(8.3%) were males and 180 (84.3%) were females and the average age of the patients studied was 35 years.

correlate between thyroid uptake with patients' diagnosis, were the diagnosis with four categories normal, hyperthyroidism, hypothyroidism and graves' disease, were the dominate thyroid uptake was from 1-4 with 147 patients (40 normal, 69 hyperthyroidisms, 28 hypothyroidism and 10 graves' disease) then 0.2 – 0.9 with 29 patients and 5-9 with 12 patents. correlate between thyroid uptake with BMI for all patients, using linear regression equation were the rate of change of thyroid uptake decrease with rate 0.0057 for each kg/cm2 from body mass index as shown in fig 1. correlate between thyroid size and BMI for all patients, using linear regression equation were the rate of change of thyroid size decrease with rate 0.0006 for each kg/cm2 for body mass index as shown in fig 2. correlate between thyroid size and thyroid uptake for all patients, using linear regression equation were the rate of change of thyroid size increase with rate 0.3189 for each unit from thyroid uptake, correlate between thyroid size and thyroid uptake for all patients, using linear regression equation were the rate of change of thyroid size increase with rate 0.3189 for each unit from thyroid uptake.
Using p. value shows that there is no significant difference between the age with thyroid size and thyroid uptake but there is a significant difference between the patience age and body mass index.

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