International Journal of Trends on OncoScience
Content Available at www.ijtos.com ISSN-2583-8431

ESTIMATE THYROID REMNANT AND METASTASIS BY A DIAGNOSTIC DOSE OF ^{131}I CINTIGRAPHY OR ^{99} M T C SCINTIGRAPHY AFTER A THERAPEUTIC DOSE OF ^{131}I.

Motwakil Imam Awad Elkareim Imam*[1], Alaa Salaheldin Ali Fadol[2], Esraa Elgaili Ahmed Ibrahim[2], Khider Ali Omer Ahmed[2]

[1]*Associate Professor of Internal Medicine, Faculty of Medicine, Shendi University, Consultant physician, Elmek Nimer University Hospital*
[2]*Medical students, Faculty of Medicine, Shendi University, Sudan*

Abstract
Background: Thyroid cancer is the only endocrine malignant tumor that is easily accessible to clinical examination, it also is the only endocrine gland where the malignant tumors affect all groups of age, both sexes, and spread by all possible routes local, lymphatic, and blood spread. Objectives:. To determine the accuracy of both imaging modalities in identifying persistent disease or distant metastases, to evaluate the impact of timing of post a therapeutic dose of 1311 on diagnostic yield. Methods: We studied 83 cases and collected data from medical records, Tumor Therapy and Cancer Research Center at Shendi University (Sudan). This study was conducted between January 2016 and August 2021. Results: in this study, we noticed that most of the participants were females and constituted 275 (79.9%) of the study participants and the majority of participants were ages above 40 years (75.9%). Forty patients (48.2%) had positive family history. Thirty-three patients (39.8%) had similar conditions, thirty-two patients (38.6%) had chronic disease, and eighteen patients (21.7%) had Cancer. The clinical presentations were dominated by: neck swelling in 45 patients (54.2%). Forty-five patients (54.2%) had follicular carcinoma 35 patients (42.2%) had papillary carcinoma and 1 patient (1.2%) had mixed carcinoma. The most common site of Mets is bone (73.5%), lymph nodes (13.2%), lung Mets (8.3%), and another part (16.8%). In diagnostic WBS, it was found that most of the remnant was follicular (58.4%), followed by papillary 41.6% and no remnant in Hürthle or mixed carcinoma. The remnant is decreased with increasing the dose which disappears in patients who took more than 150 mci. Most remnants are present in patients in the age groups above 40 years (73.9%) and the remnant is found in females 77.9%. All of metastasis (100%) is follicular cell carcinoma. The metastasis is found only in patients above 40 years old, (51.8%) between (40-60) years, and (48.4%) more than 60 years. The most of metastasis was found in females 51.5%. All cases of metastasis seen in patients received less than 80 mci. Conclusion: Neck swelling is the most presenting symptom. The most common remnant was the follicular type found in females in age above 40 years remnant decreased with increased dose that disappeared in doses more than 150mci. All metastasis is follicular, and the commonest site of metastasis is bones (73.5%), with approximately the same occurrence in both genders and absent in patients who received higher doses. Conclusion: Both 1311 scintigraphy and 99 mTc scintigraphy are effective in assessing thyroid remnants and metastases post- therapeutic 1311 dose, but their entity may depend on patient-specific factors and clinical scenarios. While 1311 scintigraphy remains the gold standard for metastatic detection, 99mTc scintigraphy offers a safer and faster alternative for evaluating thyroid remnants. We recommended the use of risk-base criteria to decide the appropriate diagnostic modality to individual patients. Consider 99mTc scinitigraphy for low-risk cases and 1311 scintigraphy for high-risk patients

Keywords: Bony Metastasis, Bone Scan, Cancer Patient, Shendi –Sudan.

***Corresponding Author**
Dr. Motwakil Imam Awad Elkareim Imam
Associate Professor of Internal Medicine, Faculty of Medicine, Shendi University,
Consultant Physician, Elmek Nimer University Hospital

DOI: https://doi.org/10.22376/ijtos.v3i2.72

Article History
Received: 19.02.2025
Revised: 02.03.2025
Accepted: 14.04.2025

1. INTRODUCTION

BACKGROUND

Thyroid - a butterfly-shaped gland that sits just below the voice box. It's only about as big as a quarter, but the hormones it makes help control how the body works, including blood pressure, heart rate, and temperature [1]. A thyroid nodule is very common in the general population (growth of cells in the thyroid gland which is called a lump) most of them are benign approximately 5% are malignant [2]. In the past 3 decades, there has been a dramatic increase in the number of thyroid cancers mainly differentiated types according to the National Cancer Institute (NCI) [3].

Thyroid cancer is the only endocrine malignant tumor that is easily accessible to clinical examination, it also is the only endocrine gland where malignant tumors occur in all groups of age, both sexes, and spread by all possible route —local, lymphatic, and blood spread [4]. Papillary and follicular are well differentiated representing 93% whereas medullary is poorly differentiated. The most frequent histological type is papillary 70-80% followed by follicular10 -2 Hürthle 0% cell 3% [5]. Ana plastic is undifferentiated represents about 13% and medullary carcinoma from Para follicular epithelium represents 6%. Papillary thyroid cancer PTC spreads to lymph nodes in the neck. It also can spread elsewhere in the body Follicular thyroid cancer FTC usually does not spread to the lymph nodes, but in some cases can spread to other parts of the body, such as the lungs or bones. Hürthle cell thyroid cancer is a variant of follicular [6]. Differentiated thyroid cancer is highly treatable and usually curable, especially in patients younger than 40 years of age, without an extension beyond the thyroid. The goals of thyroid cancer treatment focus on removing the primary tumor and disease extending beyond the thyroid (if present), minimizing treatment-related morbidity, long-term surveillance, and minimizing the risk of disease re-currency. Most patients with DTC have an excellent outlook with the use of traditional therapies, including surgical resection, radioactive iodine (RAI-131) ablation of remaining thyroid remnants, and hormone suppression. Together these achieve a 10-year survival in >90% of cases [7]. The thyroid gland absorbs nearly all of the iodine in our body through an active transport process mediated by sodium iodide symporters (NIS) also found with low levels of DTC [8]. Radiotherapy with RAI 131therapy has been used to treat benign thyroid diseases for over 50 years, Diseases of thyroid hyper-function that can be treated with RAI-131therapy include Graves's disease (GD), solitary hyper-functioning nodule, and toxic multi-nodular goiter RAI is taken into the body in liquid or capsule form, it concentrates in thyroid cells. The radiation can destroy the thyroid gland and any other thyroid cells (including cancer cells) that take up iodine, with little effect on the rest of your body. The radiation dose used here is much stronger than the one used in radioiodine scans, which were described in Tests for Thyroid Cancer [9], unfortunately, 1/3 of DTC and all anaplastic cancers don't concentrate radioiodine and have poor prognoses. Tumor recurrence is common, affecting at least 20% of patients with the disease, sometimes decades after initial therapy. Following RAI-131 therapy, post-therapy scans are performed approximately 3-10 days after the RAI-131 administration. These post-treatment scans may show additional metastasis, Extensive disease noted on post-treatment scans may alter the clinical stage in about 10%, and clinical management in 10-15% of patients [9] Finally, they are interesting tumors having a good prognosis if diagnosed early [4].

TREATMENT OF DIFFERENTIATED THYROID CANCER (DTC)

The options of the management of differentiated thyroid cancer are thyroidectomy, post-operative RAI-131 therapy, and hormone therapy [10].

RAI-131Therapy: [9] Thyroid gland absorbs nearly all of the iodine in the body. When radioactive iodine (RAI), also known as I-131, is taken into the body in liquid or capsule form, it concentrates in thyroid cells. The radiation can destroy the thyroid gland and any other thyroid cells (including cancer cells) that take up iodine, with little effect on the rest of the body. The radiation dose used here is much stronger than the one used in radioiodine scans, which were described in Tests for Thyroid Cancer. This treatment can be used to ablate (destroy) any thyroid tissue not removed by surgery or to treat some types of thyroid cancer that have spread to lymph nodes and other parts of the body. RAI -131therapy improves the survival rate of patients with DTC that has spread to the neck or other body parts, and this treatment is now standard practice in such cases. However, the benefits of RAI -131therapy are less clear for patients with small cancers of the thyroid gland that do not seem to have spread, which can often be obliterated with surgery. Radioactive iodine therapy cannot be used to treat anaplastic (undifferentiated) and medullary thyroid carcinomas because these types of cancer do not take up iodine. For RAI-131 therapy to be most effective, patients must have high levels of thyroid-stimulating hormone (TSH or thyrotropin) in the blood. This substance stimulates thyroid tissue (and cancer cells) to take up radioactive iodine. If the thyroid has been removed, one way to raise TSH levels is to not take thyroid hormone pills for several weeks. This causes hypothyroidism which in turn causes the pituitary gland to release more TSH. This intentional hypothyroidism is temporary, but it often causes symptoms like tiredness, depression, weight gain, constipation, muscle aches, and reduced concentration. Another way to raise TSH levels before RAI therapy is to give an injectable form of thyrotropin (Thyrogen), which can make withholding thyroid hormone for a long period unnecessary. This drug is given daily for 2 days, with RAI given on the 3rd day.

Most doctors also recommend that the patient follow a low-iodine diet for 1 or 2 weeks before treatment. This means avoiding foods that contain iodized salt and red dye, as well as dairy products, eggs, and seafood. 85% of patients with DTC

were cured after total thyroidectomy with lymph node dissection, radioactive iodine ablation, and TSH suppression, and a 5-year survival rate of 83-98%.

Dose of RAI -131: (100–149) mCi, (150–174) mCi, (179–199) mCi, and 200 mCi or more [10].

Two-thirds of patients with distant metastases have significant 131-I uptake and receive 100-200 mCi (3,700-7,400 MBq) every 4-6 months during the first 2 years and then at longer intervals [11].

Post-therapy scans Gamma camera imaging produces a good quality 2-dimensional representation of the distribution of radiopharmaceutical that can be greatly improved with pin-hole collimation.

Very little preparation is needed but drinking some water before imaging can clear the confusion created by pharyngeal activity consequent to salivary excretion. Certain medications that interfere with the trapping mechanism such as thyroxin, tertroxine, amiodarone and potassium perchlorate need to be stopped for variable intervals. Iodinated contrast agents produce undesirable saturation of sodium-iodide symporter that may persist for weeks particularly lipid soluble agents.

Anterior views are obtained 20 minutes after intravenous injection of 75-185 MBq 99mTcO4 supplemented by oblique and lateral views and occasionally single photon emission tomography (SPECT). Although rectilinear scanners are still in common use, they are time-consuming and less reliable than gamma cameras with overall accuracy of 77% compared to 94% for pin-hole imaging [12, 13].

PROGNOSIS OF DIFFERENTIATED THYROID CANCER

Although the prognosis of well-differentiated thyroid carcinomas with localized disease is excellent, in situations with regional disease or distant metastasis, survival is dependent on age. Both among cases of papillary and follicular thyroid carcinoma, there was higher disease-specific survival among younger patients, although this group was more susceptible to regional and distant recurrences [14, 15].

Recurrence of DTC is most commonly in the neck (thyroid bed and lymph nodes), and hence, ultrasound is the mainstay of routine follow-up of these patients. U/S can be used to accurately diagnose and identify lesions in the neck as small as 3 mm. Routine use of U/S in the 3- to 12-month monitoring of patients with extrathyroidal invasion or local-regional nodal metastases [16] Lack of RAI uptake by distant metastases confers a poor prognosis. For example, patients with no RAI uptake in the lungs have a 10-year survival rate of 25% compared with 76% in those whose lung metastases have RAI uptake pulmonary metastases that do not take up radioactive iodine do not typically respond to that radionuclide therapy, and these patients are at high risk of death [17].

PROBLEM STATEMENT

Differentiated thyroid cancer (DTC) management relies on post-therapy surveillance to detect residual thyroid tissue and metastatic disease. While post-therapeutic 1311 whole-body scintigraphy is the gold standard for identifying iodine-avid disease, concerns regarding radiations exposure, cost, and diagnostic limitations have lead to interest in alternative imaging modalities, such as 99 m T c scintigraph. However, the diagnostic accuracy, clinically utility, and cost-effectiveness of 99 m T c scintigraphin comparison to 1311 whole-body scintigraphy remain unclear. Additionally, the stunning effect of 1311 diagnostic dose may impact the interpretation of subsequent therapeutic scans. This study aims to compare the effectiveness of a diagnostic dose of 1311 scintigraphy or 99 m T c scintigraphy in detecting thyroid remnants and metastasizes after a therapeutic 1311 administration. By evaluating sensitivity, specificity, radiation exposure, and cost, the study seeks to determine whether99 m T c scintigraphy could serve as a viable alternative or adjunctive in post-treatment monitoring of DTC patients. Finding will help optimize protocols, enhance clinical decision-making and improve long-term patient outcomes.

JUSTIFICATION

1- Optimizing post-treatment monitoring: Accurate identification of thyroid remnants or metastases is crucial for guiding further treatment and follow-up in differentiated thyroid cancer.

2-Radiation dose considerations: 1311 scintigraphy exposes patients to radiation hence, 99 m T c scintigraphy could be a lower risk alternative

3-Cost effectiveness: 99 m T c scans are more widely available and less expensive, making them a viable option in resources-limited settings

4- Improved patient outcome: Early and precise detection of residual disease improves therapeutic decisions and long-term prognosis.

OBJECTIVES

GENERAL OBJECTIVES

To compare the effectiveness of diagnostic 1311 scintigraphy versus 99 m T c O 4 scintigraphy in detecting residual thyroid tissue and metastases post a therapeutic dose of 1311

SPECIFIC OBJECTIVE

To determine the accuracy of both imaging modalities in identifying persistent disease or distant metastases, to evaluate the impact of timing of post a therapeutic dose of 1311 on diagnostic yield, and to assess radiation exposure and patient safety in diagnostic imaging protocols.

PREVIOUS STUDY

Previous study done in Khartoum teaching hospital from 2007-2014, aim to report on thyroid carcinoma on patients presenting to surgical department result: 166 patients with thyroid cancer were studied, the age of the participants range between 15 - 85 years. Male to female ratio was 1:2.4. Clinical presentation was a goiter that was showing a recent rapidly growth with either respiratory choking, pain or dysphasia. FTC was 43%, PTC 27%, and plastic 10% 2%medullary,

sarcoma and lymphoma 5% and missing data in 13%. 6% of patients presented with lung and bone metastasis. Twenty patients had long standing goiter before development of cancer. Conclusion: Patients with thyroid cancer presents late. The dominance of follicular type indicates the significance of underlying endemic goiter in its [18].

Also study in South Africa in1988 by aim to analyzed national and regional (former Transvaal) incidences of DTC as a surrogate measure of the population iodine nutritional status in South Africa, They demonstrated Main results: Thyroid cancer was under diagnosed in populations other than white. Nationally, follicular histology accounted for 55% of all differentiated primary thyroid cancers, and predominated especially in black women, where papillary58% predominant in white and black patient younger than white [19].

Study of NCBI was done in Unite state in 2014 to evaluate the significance of U/S in the detection of neck recurrence in low-risk DTC patients at first follow-up visits. A total of 32 patients, who had a history of DTC and radioiodine therapy after thyroidectomy with low doses of iodine 131 were enrolled in this study. Recurrence of thyroid cancer was suspected in the neck region in 17 patients (53.1%) of the study cohort. There were six groups based on the results of post treatment serum TG levels, (131-I WBS), and US in t he detection of DTC neck recurrences. 15 patients had negative results of three modalities (group 1); 7patients had US of neck lesions but negative 131-I WBS and serum Tg (group 2); 3 patients had positive results of 131-I WBS but negative US and serum Tg (group 3); 4 patients had positive Tg results but negative US and 131-I WBS (group 4); 2 patients negative 131-I WBS but US and serum Tg suggested the diagnosis of neck recurrence (group 5), and one subject had evidence of neck recurrence in three modalities (group 6). 20

study in Izmir hospital from 2010-2011 to evaluate clinical feature of patients with thyroid carcinoma prospectively they found most of patient had low risk 90% ,intermediate 8.4 %and high risk 1.6.21

Study in Egypt in 2016 by sample size 105 to study the risk factor of DTC in Sohag ,Egypt Their result demonstrated PTC commonest type 60% & FTC 39%, negative FH of thyroid in 83% .22

Study in the National University Hospital, Singapore in may 2017, aiming to know .Patterns of metastasis in follicular thyroid carcinoma and the difference between early and delayed presentation, retrospective cohort study was conducted of patients diagnosed with FTC treated between 2000 and 2013.The median age at diagnosis was 65 years (range: 17-86 years), and 65% of the patients were female. Twelve patients (60%) were diagnosed with metastatic disease at presentation, with the bones being the most common site (75%). In the remaining eight cases (40%), metastasis developed at a median of 4.5 years (range: 2-8 years) after initial thyroid surgery, with the lungs being the most common site (50%). The overall disease-specific mortality rate was 40% 23.

LIMITATIONS

1-lower sensitivity of 99 m T c scintigraphy: It may not detect iodine-avid metastases as effectively as 1311 scan.

2-False negatives/positives: Both modalities may miss small or non-iodine-avid lesions, or misinterpret inflammatory changes as metastases

3-Radiation exposure from 1311: Even diagnostic dose contribute to cumulative radiation exposure.

4-Timing and stunning effect: Early post-therapy1311 imaging may underestimate disease due to the stunning effect reducing subsequent uptake.

5-Limited availability of comparative studies: there may be a lack of standardized protocols comparing both modalities in large patient populations.

2. METHODOLOGY

STUDY AREA AND DESIGN

The present study was a prospective, cross-sectional, hospital-based study conducted in tumor therapy and cancer research center - Shendi University Sudan. The center was established in 2010 to provide chemotherapy, nuclear medicine imaging, endoscopy services, laboratory services, radio-iodine therapy, early detection services, and Radiation therapy for cervical cancer (brachytherapy). The Teletherapy department is under establishment. This is the only center providing these services for the population in the River Nile state of Sudan. The center is located in Shendi town, it is about 150 km northern to Khartoum capital of the Sudan, and about 45 km Southern to the ancient city of Merwe. The center is located about 4km from the center of Shendi town, at the cross of the highway road from Khartoum to Atbara across the main road in the center of Shendi town. The inclusion criteria are primary DTC patients of both sex and age, who receive RIA -131 therapies, have a record in TTCRC-Shendi, and with record of both post-therapeutic and post-diagnostic WBS. We used the total coverage technique as the sampling method to collect data from the total number of included participants. Thus, the total number of included participants was 83 patients. The study was conducted from January 2016 to August 2021.

DATA COLLECTION METHOD & TOOL

Data were collected using a structured questionnaire. The questionnaire was filled directly from the medical files of the patient's records. For all the patients involved in the study whole body bone scan was done on them.

THE QUESTIONNAIRE INVOLVED DATA REGARDING

The questionnaire included items to measure sociodemographic characteristics (gender, age, residence, and marital statu.

INCLUSION CRITERIA

1-pateints diagnosed with differentiated thyroid carcinoma, including papillary or follicular carcinoma

2-individuals planned for a diagnostic dose of 1311 scintigraphy or 99 m T c O 4 scintigraphy following a therapeutic dose of 1311
3- Availability of complete clinical, pathological, and follow-up data
4-Age > 18 years

EXCLUSION CRITERIA

1-Patients who are pregnant or lactating
2-Individueals with other coexisting malignancies or significant co-morbidities that may interfere with follow-up
3- History of prior external beam radiotherapy to the neck
4- Poor adherence to preparation protocols (e.g.. low-iodine diet or stopping thyroid hormone medications)
5- Patients with contraindications to radioactive iodine or Tc-99m administration.

STATISTICAL DATA ANALYSIS

Data was reviewed, ordered, and coded, and then Statistical Package for Social Sciences (SPSS) version 20 was used for data Analysis. Descriptive statistics were used to analyze the participants' data... The data is presented in the form of figures and tables.

3. ETHICAL CONSIDERATION

Ethical approval for this study was obtained from the scientific research commitment of Shendi University and the Ministries of Health in North Sudan (SMSB-E.C.66.2021), in inconsistency with Helinsky's declaration of the international conference on harmonization, regulations, and laws of Sudan.

4. RESULTS

This is a descriptive retrospective hospital-based study that enrolled 83 Sudanese patients with thyroid cancer who attended RAI131 therapy in TTCRC-Shendi in the period from 2016 to 2021.

Table 1 Demographic factor of the participants (N = 83)

factor	Frequency	Percent%
Age group		
less than 20 years	1	1.2
20-40	19	22.9
41-60	49	59
more than 60	14	16.9
gender		
male	17	20.5
female	66	79.5
Resident		
Shendi	78	52.0
Al matama	11	7.3
Al mesaiktab	6	4.0
Alshagaloa	6	4.0
Al trajma	3	2.0
Kabosheah	5	3.3
Algeliaa	4	2.7
Dem algrai	4	2.7
Alseal	4	2.7
Alkimair	8	5.3
Alsloaab	2	1.3
Ttaibhalkhoad	3	2.0
al mahmeia	2	1.3

Al damar	6	4.0
Atbara	3	2.0
abuhamaed	1	.7
Algraef	2	1.3
Banaga	1	.7
Barbar	1	.7

Occupation		
Housewife	50	60.2
Free business	10	12
Employee	15	18
student	2	2.4
workers	6	.47
Married	73	88
Single	10	12
Educational level		
Not educate	20	24.1
Primary	25	30.1
Secondary	16	19.3
University	22	26.5
Family history		
40		48.2
43		51.8

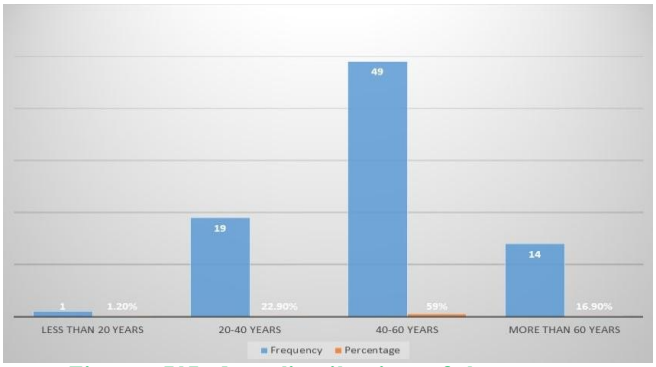

Figure [1]: Age distribution of the cases .

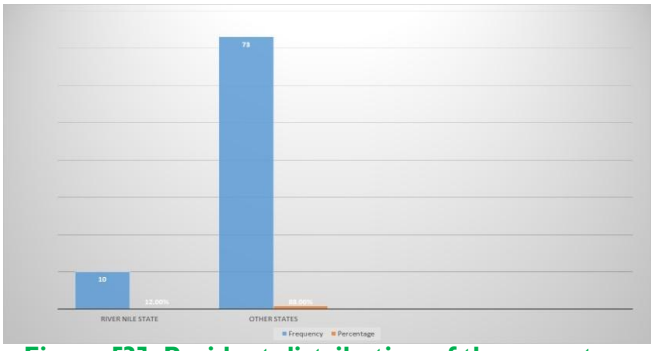

Figure [3]: Resident distribution of the cases ten patients 12.0% from the river Nile state, and 73 patients 88.0% from other states.

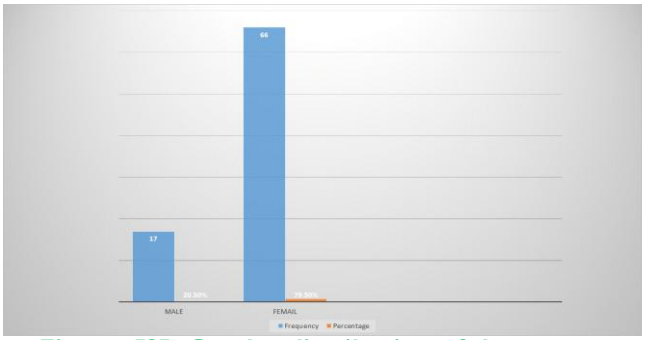

Figure [2]: Gender distribution of the cases

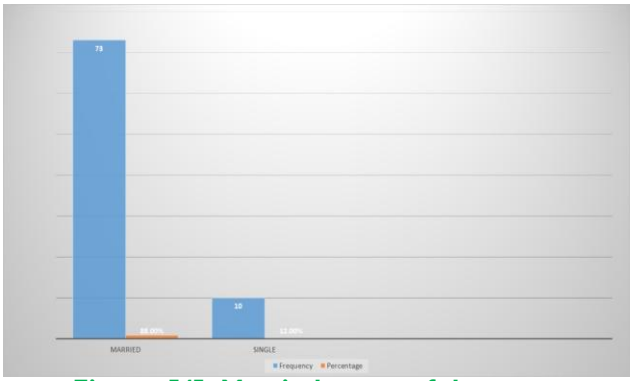

Figure [4]: Marrital status of the cases

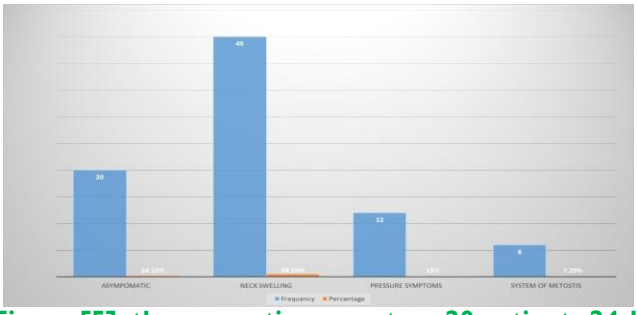

Figure [5]: the presenting symptom 20 patients 24.1 % were symptomatic, 45 patients 54.2 % presented with neck swelling, 12 patients14.5 % with Pressure symptomatic, and 6 patients 7.2 % with the symptoms of metastasis

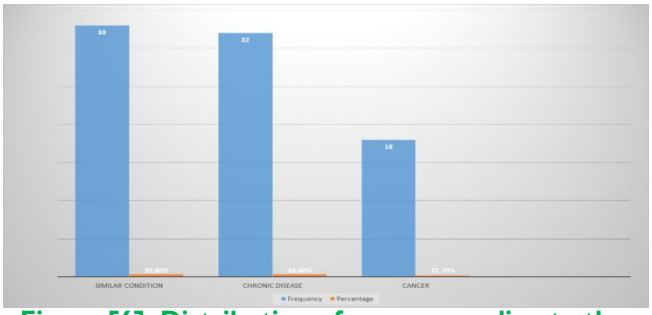

Figure [6]: Distribution of cases according to the present of past medical history

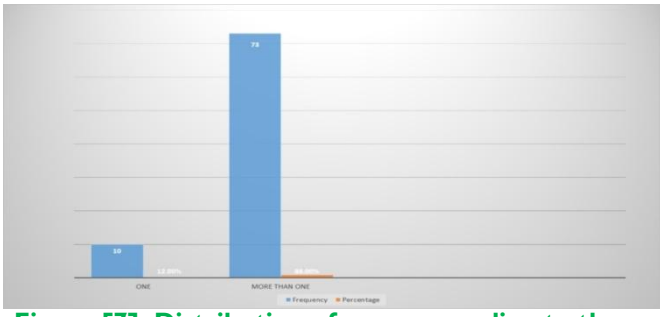

Figure [7]: Distribution of cases according to the Number of thyroidectomies 72 patients 86.7% had a single operation and 11 patients 13.3% had a recurrence

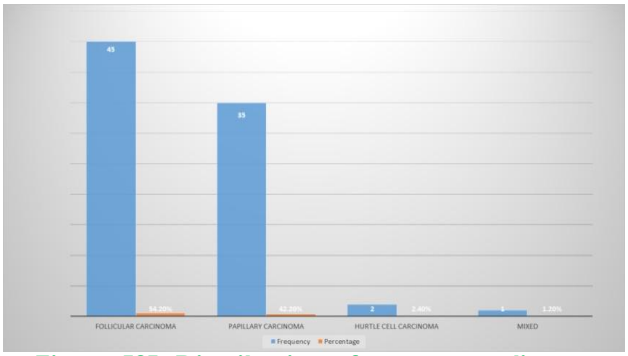

Figure [8]: Distribution of cases according to histological subtype 45 patients 54.2% had follicular carcinoma, 35 42.2% had papillary carcinoma and 1 patient had mixed carcinoma.

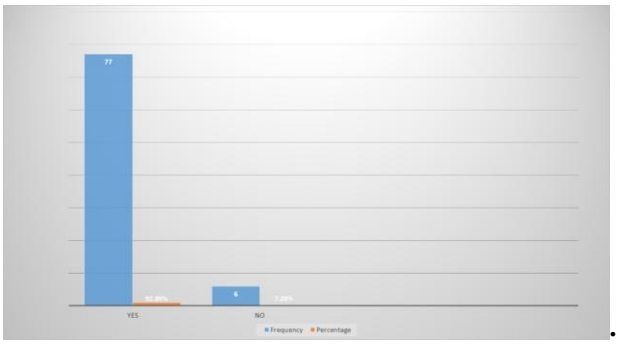

Figure [9]: Presence or absence of remnant in the result of post-therapeutic RAI WBS. Seventy-seven patients 92.6 % had remnants of thyroid tissue and just 6 patients 7.2% had no remnants.

Table [2]: Amount of first doses of RAI (131) therapy taken up by patients. Thirty-five patients 42.2% had received less than [80 mci], 30 patients 36.1% had received [80-100 mci], 15 patients 18.1% had received [101-120 mci],2 patients 2.4% had received [121-150 mci] and only one patient 1.2% had received more than [150 mci]

Dose[mci]	Frequency	Percentage
< 80	35	42.2%
80 – 100 mic	30	36.1%
101 – 120 mic	15	18.1%
121 – 150 mic	2	2.4%
More than 150 mic	1	1.2%
Sum	83	100%

Table [3]: Number of doses of RAI (131) therapy taken up by patients.

Number of doses	Frequency	Percentage
Only one dose	47	42.2%
2 Doses	29	36.1%
3 Doses	2	18.1%
More than 3 doses	5	2.4%
Sum	83	100%

Table [4]: Metastatic status in the result of post-therapeutic RAI WBS, Thirty-three patients 39.8% had metastasis, 16 were single 17 were multiple, and 50 patients 60.1% had no metastasis to any site..

Status of metastasis	Frequency	Percentage
Present	33	39.8%
a- Single b-Multiple	16 17	
Absent	50	60.2%
Sum	83	100%

Table [5]: Sites of metastasis in the result of post-therapeutic RAI WBS, Twelve patients were 19.7% to the skull, 11 patients were 18% to the ribs, 6 patients were 9.8% to the vertebrae, 7 patients were 11.5% to the femur, 11 patients were 18% to the humer, and 14 patients were 23% to others. Of two patients 5.4% had to liver, 10 patients had 27% to lung, 11 patients had 29.7% to lymph nodes, and 14 patients had 37.8% to other organs.

Bone			Organs		
	Frequency	Percentage		Frequency	Percentage
Skull	12	19.7%	Liver	2	5.4%
Ribs	11	18.0%	Lung e	10	27.0%
Vertebrae	6	9.8%	Lymph node	11	29.7%
Femur	7	11.5%	Other	14	37.8%
Humerus	11	18.0%	Sum	37	100%
Other	14	23.0%	-	-	-
Sum	61	100%	-	-	-

Table [6]: Presence or absence of remnant in the result of post-diagnostic RAI WBS.72 patients 86.7% had remnant and 11pateints 13.3% had no remnant

Answer	Frequency	Percentage
Yes	72	86.7%
No	11	13.3%
Sum	83	100%

Table [7]: Metastatic status in the result of post-diagnostic RAI WBS Twenty-nine patients 34.9% had metastasis, 14 of them were single and 15 were multiple, 54 patients 65.1% had no metastasis to any site

Answer	Frequency	Percentage
Present	29	34.9%
a- Single b-Multiple	14 15	48.3% 51.7%
Absent	54	65.1
Sum	83	100%

Table [8]: Sites of metastasis in the result of post-diagnostic RAI WBS patients 8.5% to the skull, 10 patients 21.3% to ribs, 4 patients 8.5% to vertebrae, 5 patients 10.6% to femour, 7 patients 14.9% to homer, 17 patients 36.2% to others. Three patients 10% to liver, 10 patients 33.3% to lung,7 patients 23.3% to lymph node,10 patients 33.3% to others

Bone			Organs		
W2	Frequency	Percentage		Frequency	Percentage
Skull	**4**	8.5%	Liver	3	10.0%
Ribs	**10**	21.3%	Lung e	10	33.3%
Vertebrae	**4**	8.5%	Lymph node	7	23.3%
Femur	**5**	10.6%	Other	10	33.3%
Humerus	**7**	14.9%	Sum	30	100%
Other	**17**	36.2%	-	-	-
Sum	**47**	100%	-	-	-

5. DISCUSSION

In this hospital-base retrospective study, we described the clinical presentation, type of carcinoma, number and amount of doses of radioactive iodine, and result of post-therapeutic and post-diagnostic scan, whether there is a remnant and or Metastasis or not, and its site if present in 83 patients with differentiated thyroid cancer in TTCRC Shendi which the only center provide this service in Sudan. Which has a department for radioactive iodine therapy, nuclear physiotherapist, oncologist, and diagnostic nuclear medicine (gamma camera), the most common age of presentation is found to be (40-60) years old representing 59% of the patients, this near to which reported in a study done in south African national cancer Registry (1988) aim to analyze national and regional incidences of DTC and Study done in national cancer institute (NCI) in Unite state in 2014 to evaluate the significance of U/S in the detection of neck recurrence in low-risk DTC patients at first follow-up visits [18,19].

Regarding gender distribution, DTC is more common in females than males approximate ratio (of 3.9:1), which is almost near to what was reported in a study done in Khartoum Teaching Hospital from 2007 to 2014, aimed to report on thyroid carcinoma in patients presenting to surgical department (2.4:1) and lower to NCI in united states (3:1) [20,21].

In this study, there were 48.2% of patients with a positive family history of thyroid cancer which is higher than the Study done in Egypt in 2016 about the risk factors of DTC in Sohag.

The most common type was found to be FTC (54.2%) followed by PTC (42.2%) which is very close to local study in Khartoum and study of South Africa, and against what is mentioned in Sohag, Egypt where PTC is higher than FTC [20, 21].

Most of our patients 42.2% received less than 80 mci of RAI131 as the initial dose this is near close to the study done in a study in Izmir Hospital in January 2016 aiming to study the importance of diagnostic 1131 scintigraphy in clinical follow-up [22].

This study found that successful ablation occurred in 5.9% near to Izmir hospital study, and found the most common site of Metastasis is bone at 73.5%, followed by lymph nodes at 13.2%, and lungs at 8.3% compared with a Study done in the USA about Metastasis at DTC in August 2006 found that 50% of patients with lung metastases and 25% bone metastases this because study of USA include just metastasis DTC and our study included all patients with DTC in which only 39.8% with Metastasis [22].

In diagnostic WBS which was done after six months, it was found that most of the remnant was follicular (58.4%), followed by papillary 41.6% and no remnant in hurthle or mixed carcinoma.

the remnant is decreased with increasing the dose in which 46.1% of pt with the remnant took <80mci, 38.9% (80-100) mci,15.6% (101-120)mci,0% (121-150) and it disappears in patients taking more than 150 mci.

-most ruminants present in patients in the age group above 40 years (73.9%), 24.7% of them between (20-40) and only 1.2% less than 20 years old.

-Regarding gender, most of the remnants are found in females with 77.9% against 22.1% in males.

-all of the metastasis (100%) was follicular cell carcinoma and no metastasis in other types. Metastasis is found only in patients above 40 years old .51.8% between (40-60) years and 48.4% more than 60 years, with no metastasis below 40 years old.

Most of the metastasis was found in females 51.5% and about 48.5% was found in males, this is not far different from a study conducted at the National University Hospital, Singapore aiming to study the pattern of metastasis in follicular thyroid carcinoma in May 2016 which found that in patients with metastasis as the initial presentation, the median age was 65 years old and 65% of patients were females [23].

-All cases of metastasis were found in patients who received less than 80 mci and metastasis was absent in patients who received higher doses.

6. CONCLUSION

Both ^{131}I scintigraphy and 99 mTc scintigraphy are effective in assessing thyroid remnants and metastases post- therapeutic ^{131}I dose, but their entity may depend on patient-specific factors and clinical scenarios. While ^{131}I scintigraphy remain the gold standard for metastatic detection, 99 mTc scintigraphy offers a safer and faster alternative for evaluating thyroid remnants. The choice of imaging modality should consider the patient's clinical profile, risk of metastasis, and overall treatment goals.

6. RECOMMENDATIONS

1- Patient Stratification: Use risk-base criteria to decide the appropriate diagnostic modality to individual patients. Consider 99Tc scinitigraphy for low-risk cases and ^{131}I scintigraphy for high-risk patients

2-Protocol Stratification: Develop standardized protocols for patient preparation, imaging timing, and dose administration to improve diagnostic consistency and accuracy.

3- Future research: Encourage studies comparing the cost-effectiveness and long-term outcomes of both techniques in large cohorts, including the use of recombinant TSH.

4- Avoid Stunning Effect: Minimize the dose of diagnostic ^{131}I or explore alternative imaging methods like PEC/CT WITH ^{124} I in sensitive cases.

5-Patient Education: Provide comprehensive counseling about the benefits and risks of each diagnostic modality to enhance adherence and satisfaction.

6- Establishment of nuclear medicine centers in other cities of Sudan and Improvement of the health services.

7. AUTHORS CONTRIBUTION STATEMENT

All authors contributed to the study's conception and design. Material preparation and data collection were performed by Motwakil Imam Awadelkareim. The analysis and final draft were done by AIAA SALAHELDIN ALI FADOL, ESRAA ELGAILI AHMED IBRAHIM, and KHIDER ALI MER AHMED. The first draft of the manuscript was written by Motwakil Imam Awadelkareim. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

8. ACKNOWLEDGMENT

Great thanks to every member of the gripping university Shendi University.

9. CONFLICT OF INTEREST

The authors declared no conflict of interest.

10: ABBREVIATIONS

Abbreviation	Term
NCI	National Cancer Institute
TTCRC	Tumor Therapy and Cancer Researchers Center
WBS	Whole Body Scan
MCI	Millicurie
SPECT	Single Photon Emission Computing Tomography
PTC	Papillary Thyroid Cancer
FTC	Follicular Thyroid Cancer
DTC	Differentiated Thyroid Cancer
NIS	Sodium Iodine Symporters

GD	Graves Disease
RAI	Radio Active Iodine
TG	Thyroglobulin
DIT	Di Iodine Tyrosine
MIT	Mono Iodine Tyrosine
ATP	Adenosine Tri Phosphate
TBG	Tyrosine Binding Globulin
TBPA	Tyrosine Binding Pre Albumin
FNA	Fine Needle Aspiration
FAP	Familial Adenomatous Polyposis
TSH	Thyroid Stimulation Hormone
US	Ultra Sound

11. Appendixes

Examples **post therapy ^{131}I(100 mci) whole body scan** of some patients enrolled in this study with different types of thyroid cancers

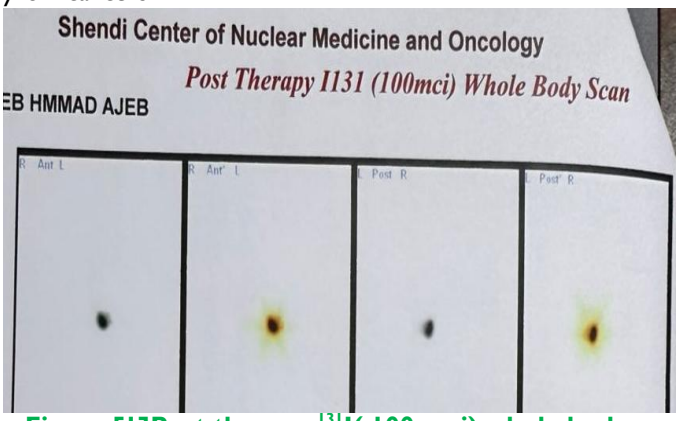

Figure [1]Post therapy ^{131}I(100 mci) whole body scan : anterior and posterior views obtained (5days) after therapeutic dose of ^{131}I revealed residual functioning thyroid tissue in thyrid bed and no distant metastasis

Figure [2] Post therapy ^{131}I(100 mci) whole body scan : anterior and posterior views obtained (5days) after therapeutic dose of ^{131}I revealed residual functioning thyroid tissue in thyrid bed and distant metastasis involving both lungs and left illiac bone

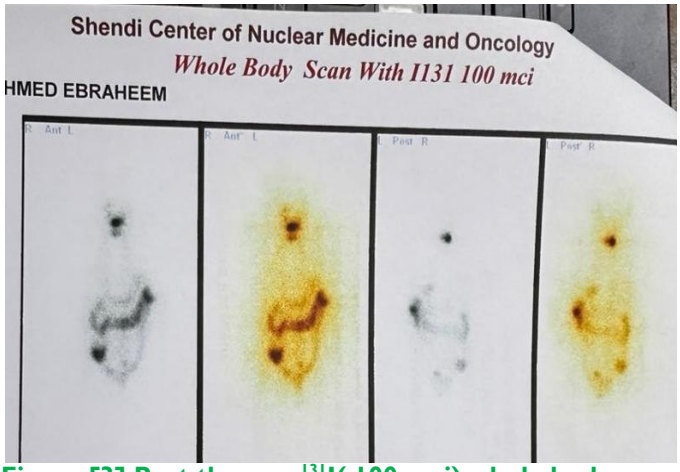

Figure [3] Post therapy ^{131}I(100 mci) whole body scan : anterior and posterior views obtained (5days) after therapeutic dose of ^{131}I revealed residual functioning thyroid tissue in thyrid bed and no distant metastasis.

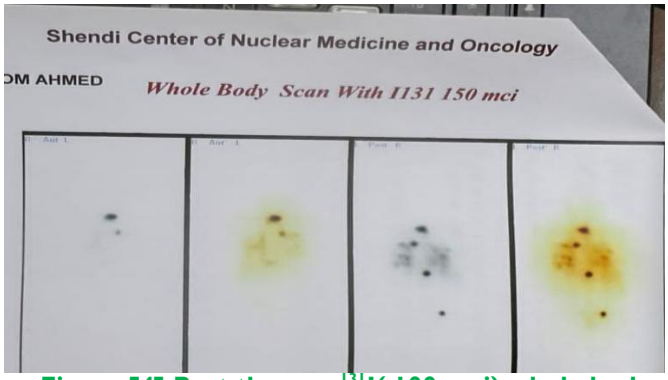

Figure [4] Post therapy ^{131}I(100 mci) whole body scan : anterior and posterior views obtained (5days) after therapeutic dose of ^{131}I revealed residual functioning thyroid tissue in thyrid bed and distant metastasis involving both lungs, right side pelvic bone and lumbar vertibrae

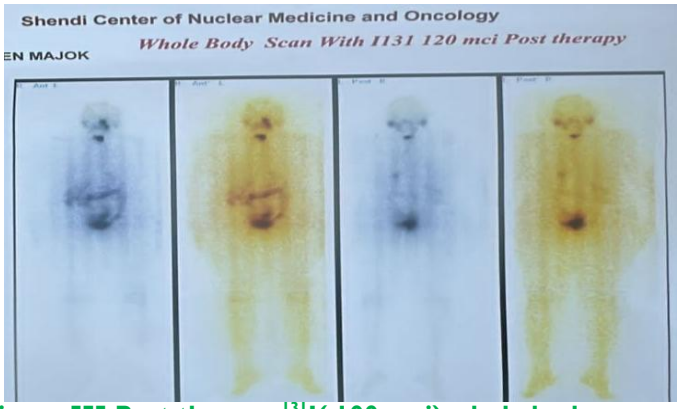

Figure [5] Post therapy ^{131}I(100 mci) whole body scan : anterior and posterior views obtained (5days) after therapeutic dose of ^{131}I revealed residual functioning thyroid tissue in thyrid bed and no distant metastasis

12. REFERENCES

1. Blahd. W, What Is Papillary Thyroid Carcinoma, September 9, 2016 Available on (http//www.webmed.com/willim-blahd)last accessed on November 2017 .
2. Cooper DS, Doherty GM, Haugen BR, et al for the American Thyroid Association ATA guidelines task force on thyroid nodule and DTC. Thyroid .2009; 19:1167-1214 .
3. Snapshot of thyroid cancer; national cancer institute .November5, 2014 available on: (http// www.cancer.gov/researchandfunding/snapshot/thyroid.)La st accessed janaury12, 2015
4. Rajgopal S.K, Manipal manual of surgery, 3edition, New Delhi ,CBS publisher 2010; 416
5. Andrson.R. Vanita. T, Linnehan E. JL, Wirth LJ, Clinical Safety and Economic Evidence in Radioactive Iodine–Refractory Differentiated Thyroid Cancer, THYROID, 23, 42013; 392.
6. Olney., Papillary and Follicular Thyroid Cancer and their variants, including Hurthle cell, tall cell, and others, Thyroid Cancer Survivors' Association, Inc. May 11,2015Thyroid (thyca@thyca.org)
7. Baranauskas Z.1, Valuckas KP, Tiskevicius: Outcomes of long-term combined treatment in follicular thyroid carcinoma Medicina (Kaunas) Lithuania .2010; 46(4):268-74.
8. Cooper DS, Doherty GM, Haugen BR, Kloos RT, Lee SL, Mandel SJ, Mazzaferri EL, McIver B, Pacini F, Schlumberger M, Sherman SI, Steward DL, Tuttle RM, American Thyroid Association management guidelines for patients with thyroid nodules and differentiated thyroid cancer,2009, 19:1167–1214
9. Iodine (Radioiodine)Therapy for Thyroid Cancer, American Cancer Society, March 31, 2016, Last Revised: April 15, 2016, available on (http://www.bing.com/search?q=Radioactive
10. BAL S.C, .and, PadhyAK, Radioiodine Remnant Ablation: A Critical Review; World J Nucl Med. 2015 Sep-Dec; 14(3): PP144–155Department of Nuclear Medicine, All India Institute of Medical Sciences, and New Delhi, India
11. Rivkees SA, Mazzaferri EL, Verburg FA, Reiners C, Luster M, Breuer CK, Dinauer CA, Udelsman R. The treatment of differentiated thyroid cancer in children: emphasis on surgical approach and radioactive iodine therapy. Endocr R. 2011; 32:798–826. Doi: 10.1210/er.2011-0011.
12. NUCLEAR MEDICINE IN THYROID CANCER MANAGEMENT: A PRACTICAL APPROACH, IAEA, VIENNA, 2009, ISBN 978–92–0–113108–9, ISSN 1011–4289, © IAEA, 2009, Printed by the IAEA in Austria, March 2009.
13. Frilling A, Gorges R, Tecklenborg K et al., "Value of preoperative diagnostic modalities in patients with recurrent thyroid carcinoma," Surgery, vol. 128, no. 6, pp. 1067–1074, 2000 .
14. Ito Y, Miyauchi A, Kihara M, Higashiyama T, Kobayashi K, Miya A. Prognostic significance of young age in papillary thyroid carcinoma: analysis of 5,733 patients with 150 months median follow-up. Endocr J 2014; 61(5):491-497
15. Ito Y, Miyauchi A, Tomoda C, Hirokawa M, Kobayashi K, Miya A. Prognostic significance of patient age in minimally and widely invasive follicular thyroid carcinoma: investigation of three age groups. Endocr J 2014; 61(3):265-271
16. Schlumberger M.J, papillary and follicular thyroid carcinoma New England Journal of Medicine Vol .338, no5pp.279-1998 .
17. A. Antonelli, P. Miccoli, M. Ferdeghini et al., "Role of neck ultrasonography in the follow-up of patients operated on for thyroid cancer," Thyroid, vol. 5, no. 1, pp. 25–28, 1995 .
18. Kall W.J, Sitas F, Patterson A.C, Thyroid cancer in South Africa - an indicator of regional iodine deficiency, SAMJ, Jun 1997, Volume 87 No.6 peg 736:737
19. Moslehi M, Assadi M1 Contribution of ultrasound examination in the detection of neck recurrence in low-risk differentiated thyroid carcinoma patients at first follow-up visits Nucl Med Rev Cent East Eur. 2014;17(1):3-6.
20. Ahmed M .E. Thyroid carcinoma in The Sudan [abstract]. In: Proceedings of the American Association for Cancer Research Annual Meeting 2017; 2017 Apr 1-5; Washington, DC. Philadelphia (PA): AACR; Cancer Res 2017; 77(13 Suppl): Abstract nr 5632 .
21. Abstract. Bailey RK, Geyen DJ, Scott-Gurnell K, Hipolito MMS, Bailey TA, Beal JM. Understanding and treating depression among cancer patients. Int J Gynecol Cancer 2005; 15:203–208
22. AliA.R, BackeetR.A, Alsaayed W.A, International Journal of Current Research in Medicine Sconces Nov201Volume 2, 27:34
23. Durante C1, Haddy N, Baudin E, Leboulleux S, Hartl D, Travagli JP, Caillou B, Ricard M, Lumbroso JD, De Vathaire F, Schlumberger MLong-term outcome of 444 patients with distant metastases from papillary and follicular thyroid carcinoma: benefits and limits of radioiodine therapy. J Clin Endocrinol Metab. 2006 Aug; 91(8):2892-9. Epub 2006 May 9.