Chapter One

Introduction

Chapter One

1.1.Introduction

Thyroid tumors are usually nodules localized to the thyroid gland, and are often palpable on examination of the anterior neck.Radioactive iodine treatment is a type of internal radiotherapy that has been used effectively for the treatment of differentiated Thyroid cancer after thyroidectomy, Treatment of differentiated thyroid cancer (DTC) with Radioactive iodine (131I; often referred to as ‘radioiodine’) it’s a standard procedure for the ablation of Remnant thyroid tissue following surgery and for the Treatment of iodine-avid metastases, activity of radioiodine to treat metastatic thyroid carcinoma is the lowest possible amount of radioiodine that delivers a lethal dose of radiation to the entire lesion/metastasis while minimizing side effects. an optimized treatment activity based on prior measurement of the patient’s individual bio kinetics .131I Recommended to be administered In many cases and dosimetric studies they allow the evaluation of the risk associated with the contamination of the different healthy tissues by Monte Carlo simulation (VMC code), VMC can be considered a “specialized” Monte Carlo program as it is designed specifically to solve radiation protection problems, and the main geometry used is the matrix, matrices containing two or more anthropomorphic phantoms and special geometries for source tissues, such as the endosteum/cortical bone interface may be simulated ,the development of Visual Monte Carlo (VMC) started in 1992 at the Instituto de Radioproteção e Dosimetria, VMC dose calculation, for dose calculations due to exposure to radionuclides or X-rays ,VMC began as a solution to the problem o f photon transport through phantoms representing the human body.(Latin American IRPA Regional Congress on Radiation Protection and Safety - IRPA 2013), followed by the detection of the photons leaving the human bodyand to take appropriate medical decisions in radiotherapy, optimization of the standard treatment can assessing accurate dose values, specific to each patient (Hänscheid H et al 2006 and Shahbazi-Gahrouei D et al 2015*)*.

1.2.Problem:

Lake of knowledge internal absorbed dose from thyroid cancer therapy and if it is in tolerance range we studied this to avoid the expected hazard

1.3.Objectiveof the study:

1.3.1.General Objective:

Measurement of internal radiation dose of thyroid by iodine 131 by Monte Carlo simulation and comparing the result baseline value.

1.3.2.Specific objective:

Measurement of effective dose in radioiodine therapy by Monte Carlo simulation, make correlation between Thyroid dose\Gy and (age \Year-weight\Kg-Hight\cm) and Activity vs Time\day.

1.4. Overview of the Study:

The study falls into five chapters, In chapter one, the researcher presents an introduction, a clear statement of the study problem and the objectives of the study.Chapter two contains the background and previous work performed in this field.Chapter three describes the materials and methods used to measure internal dose for thyroid cancer patient and effective dose,explained in details the methods used for dose calculation.Chapter four deals with results and chapter five presents the discussions , conclusion and recommendations.

Chapter Two

Background and literature review

Chapter two

Background and literature review

2.1.TheoreticalBack ground:

Two types of biological effects of ionizing radiation are known: deterministic effects and stochastic effects. Deterministic effects are those caused by the decrease in or loss of organ function due to celldamage or cell death. For these effects threshold doses exist: the function of many organs and tissues is not affected by small reductions in the number of available healthy cells. Only if the decrease islarge enough, will a clinically observable pathological function appear. In the case of treatment of thyroid cancer, metastases and hyperthyroidism, theobjective is to bring about the cell-killing effect while not affecting other organs in such a way thatdeterministic effects occur. Due to the capacity of thyroid cells to take up iodine thyroid diseases can be treated with radioactiveiodine.The β-emitting I-131 is often the radionuclide of choice for these treatments, although the associated γ-emission gives rise to exposures to other tissues and even to other individuals. The probability of a radiation-induced fatal cancer for the average population has been estimated(ICRP-60) at approximately 5 percent per sievert2 for low doses and at low dose rates and at 1 percent for serious genetic diseases. For elderly people, older than about 60 years, the probability seems to be 3to 10 times lower. This is because the future life span of elderly people may not be long enough for the cancer to become apparent and it is also unlikely that genetic damage is passed to offspring. Forchildren up to the age of 10 years, the probability of fatal cancer induction seems to be about 2-3 timeshigher(-European commission 97,1998)

For pregnant women the risk is the same as for the average population; however, the unborn child isassumed to have the same risk of developing a fatal cancer as young children. Deterministic effectshave been observed after massive irradiation in utero, but dose levels incurred by family or closefriends from a treated patient are far below the threshold for such effects.As sensitivity to ionizing radiation is different for different age categories, instructions to reduce therisk for these groups will also vary accordingly(-European commission

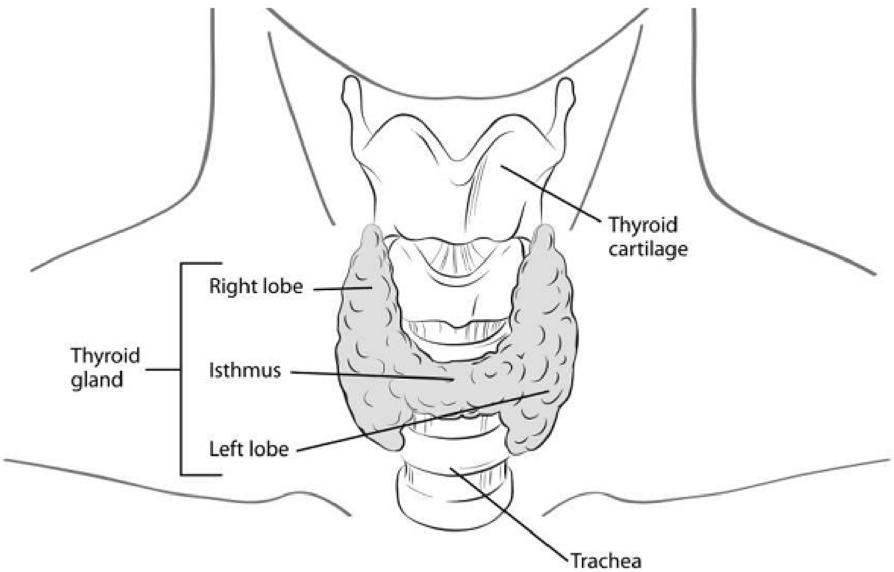
97,1998)Treatment of differentiated thyroid cancer (DTC) with radioactive iodine (131I; often referred to as ‘radioiodine’) is a standard procedure for the ablation of remnant thyroid tissue following surgery and for the treatment of iodine-avid metastases, Incidence of thyroid cancer depends on many factors, including thyroid dose and age at the time of exposure(Latin American IRPA,2013).

The ‘optimal’ activity of radioiodine to treat metastatic thyroid carcinoma is the lowest possible amount of radioiodine that delivers a lethal dose of radiation to the entire lesion/metastasis while minimizing side effects., There is a broad range of fixed activities of 131I recommended to be administered (Lassmann et al 2010)

2.2.Dose to other people:

Generally speaking, direct external radiation from the patient and exhalation of I-131 are possible sources of significant dose in other persons, we divide the individuals that may come in contact with a treatedpatient into two groups: the family and close friends on the one hand, and third persons on the other. The first group, including visitors, can be further divided into six categories: pregnant women,children up to 2 years old, children from 3 to 10 years of age, partners, partners above 60 years old anotherindividuals. As explained before, these categories are chosen because (i) unborn children and children up to 10years of age are more radiosensitive for cancer induction, (ii) small children up to about the age of 2years often have more close physical contact with their parents and (iii) people older than about 60year of age are less likely to express a cancer arising from ionizing radiation. These differences are ofspecial importance when considering instructions for patients((-European commission 97,1998).

2.3.Anotomy:Thyroid Gland



2.3.1.Thyroid gland:

2.3.1.1.Position and relations:

- **Clasps anterior and lateral surface of pharynx, larynx, oesophagus and trachea “like a shield ”**‘Lies deep to sternothyroidand sternothyroidmuscles
- **Parathyroid glandsusually** lie between posterior border of thyroid gland and its sheath (usually 2 on each side of the thyroid), often just lateral to anastomosis between vessel joining superior and inferior thyroid arteries
- **Internal jugular veinand common carotid** artery iepostero-lateral to thyroid

- **'Recurrent laryngeal nerveis an important structure** lying between trachea and thyroid–may be injured during thyroid *surgery* .
- **Each lobe**–pear-shaped and ~5cm long–extends inferiorly on each side of trachea (and oesophagus), often to level of 6thtracheal cartilageAttached to arch of cricoid cartilage and to oblique line of thyroid cartilage–moves up and down with swallowing and oscillates during speaking(Mahdy 2006).

The thyroid gland uses iodine to produce thyroid hormones which help regulate growth and metabolism. Iodine has a strong affinity for the thyroid gland, which is

the critical target organ for exposure. Iodine is readily absorbed from the gastrointestinal tract and lungs into the bloodstream. Most of the iodine that enters the body quickly becomes systemic, with approximately 30% depositing in the thyroid.

Exposure to I-131, especially in childhood, increases the risk for hypothyroidism, thyroid nodules, and cancer, The metabolism of iodine is linked closely with the functional activity of the thyroid. The portion of systemic iodine that redistributes to the thyroid ranges from 20% (for hypothyroidism or iodine-rich diets) to 75% (for hyperthyroidism or iodine-deficient diets), with an average of 30%–50% for normal diets. The rest is excreted via urine, estimating the radiation dose delivered by I-131 radiation to either the thyroid or the whole body involves multiplying the activity inhaled or ingested by an age-specific dose factor. Activity inhaled is the product of the mean air concentration of I-131, respiratory rate, and exposure time. Activity ingested is the product of the mean concentrations of I-131 in both food and water and the amounts of each consumed A child's thyroid dose from ingestion can be up to 20 times that of an adult because the same amount of energy is deposited in a smaller tissue mass. (ATSDR Publication No.: ATSDR-HE-CS-2004-0001, 2002-2008).

2.4.Physiology:

2.4.1.The thyroid produces and secretes 2 metabolic hormones:Thyroxine (T4) and triiodothyronine (T3), Required for homeostasis of all cells, Influence cell differentiation, growth, and metabolism, considered the major metabolic hormones because they target virtually every tissue.

2.4.2.TRH:Produced by hypothalamus,travels through portal venous system to adenohypophysis,downregulatedby T3,stimulates TSH formation.

2.4.3.Thyroid-Stimulating Hormone (TSH):Upregulatedby TRH Downregulatedby T4, T3, travels through portal venous system to cavernous sinus, body,stimulates several processes(Iodine uptake,Colloidendocytosis,Growth of thyroid gland),produced by adenohypophysisthyrotrophs.

2.4.4.Biosynthesis of T4 and T3:The process includes, Dietary iodine (I) ingestion, active transport and uptake of iodide (I-) by thyroid gland, Oxidation of Iodination of thyroglobulin (Tg) tyrosine residues , Coupling of iodotyrosine residues (MIT and DIT) to form T4 and T3 ,Proteolysis of Tg with release of T4 and T3 into the circulation

2.4.5.Iodine Sources: Available through certain foods (eg, seafood, bread, daitry products), iodized salt, or dietary supplements, as a trace mineral, The recommended minimum intake is 150 µg/day

2.4.6.Production of T4 and T3 :T4is the primary secretory product of the thyroid gland, which is the only source of T4, The thyroid secretes approximately 70-90µg of T4 per day,T3is derived from 2 processes(The total daily production rate of T3 is about 15-30 µg,about 80% of circulating T3),comesfrom deiodination of T4 in peripheral tissuesAbout 20% comes from direct thyroid secretionT4: A Prohormone for T3. T4 is biologically inactive in target tissues until converted to T3,activation occurs with 5'iodination of the outer ring of T4. T3 then becomes the biologically active hormone responsible for the majority of thyroid hormone effectssites of T4 conversion,The liver is the major extrathyroidal T4conversion site for production of T3,Some T4 to T3conversion also occurs in the kidney and other tissues(Mahdy 2006).

2.5.Pathology:

2.5.1.Thyroid Tumors:

Even in the absence of exposure to I-131, thyroid tumors are the most common endocrine neoplasms. Thyroid tumors are usually nodules localized to the thyroid gland, and are often palpable on examination of the anterior neck. I-131 exposure increases the risk of thyroid nodules and cancer. Thyroid cancer is rare. The mean rate of spontaneous thyroid cancer is one in 1 million for children (10 in 1 million for adults), with a female-to-male ratio of 3 to 2. The increased risk for thyroid cancer is especially important for exposures to I-131 during childhood. The incidence of thyroid nodules increases with age. However, thyroid cancer in children often presents at a more advanced stage than in adults: more distant metastases, more lymph node involvement. The risk of recurrence is higher in children, but the death rate (at least over 20 years) is much lower in children than in adults(ATSDR Publication No.: ATSDR-HE-CS-2004-0001,2002-2008)

2.6.Imag:

2.6.1.Ultrasound:Ultrasonography

„2.6.1.1. Thyroid versous.non-thyroid:good screen for thyroid presence in

children,cystic vs. solid,Localization for FNA or injection,Serial exam of nodule size(2-3 mm lower end of resolution),May distinguish solitary nodule from multinodular goiter(Dominant nodule risks no different).

2.6.1.2..Findings suggestive of malignancy:Presence of halo,Irregular border

„,Presence of cystic components,Presence of calcifications,Heterogeneous echo pattern,Extrathyroidalextension,No findings are definitive(Mahdy 2006).

2.6.2.Computed Tomography:

Because of it's iodine content ,the thyroid gland appears hyperdense compared with sourounding muscle both before and after and even more so after administration of CM,the parenchyma of the thyroid gland should appear sharply demarcated and have an homogeneous pattern in ct scan the average transverse diameter of each lobe is 1-3 cm ,1-2 cm sagittaly and 4-7cm in craniocaudal direction .the total volume of the thyroid gland various between 20 and 25ml .

The parenchymal structure of thyroid carcinoma appears inhomogeneous ,and the contour are not easy distinguish from remaining normal normal parenchymal in advanced stages of carcinoma,cervicalvessele and nerves are completely surrounded by tumor and areas of necrosis appear the trachea walls are compressed and become infiltrated ,after partial resection of astruma some thyroid tissue may still be seen to the trachea . in this case the left internal jugular vein was also removed and the lumen of the right one is large than normal(Mattiashofer :(2016)

2.6.3.Magnetic Resonant Imaging:

The use of a surface coil for neck imaging is essential due to the small volume of tissue. High-resolution T1- and T2-weighted spin-echo sequences

are useful for visualizing soft tissue. The use of gadolinium-chelated contrast agents may be helpful for tumor and lymph node detection, and for

thyroid and parathyroid studies. The addition of fat suppression to postcontrast studies is helpful to delineate tissue. Uniform fat suppression may

be difficult to achieve due to magnetic field distortions from the large magnetic susceptibility differences between the neck and the upper thorax.(BrownMarkA:(2003)).

2.6.4.Nuclear medicine

2.6.4.1.Iodine131

fission product,Cheap,widelyavailable,Better for mets(diagnostic and therapeutic)(high radiation exposure),Is radioactive, has an 8.03day half-life, and emits beta and gamma radiation,I-131is normally present at low levels in hospital nuclear medicine departments, in patients administered radioactive iodine in the last 3 months, and in releases from nuclear power plants I-131is normally present at low levels in hospital nuclear medicine departments, in patients administered radioactive iodine in the last 3 months, and in releases from nuclear power plants The main sources of I-131 in the environment have come from nuclear power plant releases and from the production and testing of nuclear weapons The activity of I-131 (quantity of radioactive material present), the exposure route, and the individual's age are factors that determine the exposure dose from radiation Infants' and children's increased rate of growth and development make them more vulnerable to radiation exposures, doses of I-131 that result from medical procedures, including therapeutic thyroid ablations, release low levels of radiation in hospital nuclear medicine departments. Therapeutic thyroid ablations have a mean thyroid dose of 10–100 Gray (Gy) to the patient, which is equivalent to a radiation absorbed dose (rad) of 1,000–10,000,ablations significantly exceed an entire year's worth of background radiation. Patients undergoing this procedure release low levels of radiation for about 3 months,The critical target organ for I-131 is the thyroid gland(ATSDR Publication No.: ATSDR-HE-CS-2004-0001,2002-2008).

2.6.4.2.**Radioactive iodine uptake**:radio labeled Iodine (I-123) is given to the patient which is actively trapped and concentrated by the thyroid gland. Measurements of % of the administered dose localizing to the gland at a fixed time. ,reflects gland function. Normal 24 hour uptake is ~10 to 30%(Mahdy 2006).

2.6.4.3.Radiation exposure from iodine131):

In many cases, an activity between 1.1 and 3.7 GBq is prescribed for the first radioiodine therapy after thyroidectomy, The administration of 131I is normally by the oral route, (66-Hamizah NMZ,2012).

I(131) emits both negative beta particles with maximum energy approximately 807 keV which delivers the major radiation dose to the remnant thyroid tissue and a prominent 364-keV gamma photon which poses a potential radiation hazard to others outside the patient's room The patients become a risk of radiation exposure and potential radiation hazards to the other individuals after radioiodine therapy administration. Most patients who receive high dose of I(131) therapy are isolated in a private room from two to three days to allow the radiation exposure rates drop to the accepted levels for radiation protection purposes The isolation procedures are commanded to minimize the transfer of contamination to the hospital personnel or visitors. Upon released of the patient, it is required to properly instruct them in order to minimize the radiation contamination and exposure to the person living with or coming in contact with the patient , Radioiodine is secreted in body fluids such as sweat and saliva and excreted into urine and faeces The amount of residual thyroid tissue in thyroid cancer patient determines the radioiodine retention and clearance rate. Patients undergoing second treatment will have less thyroid tissue compared to those undergoing initial treatment, thus they have higher clearance rate. In cancer patients, because of the lack of thyroid tissue, most of the administered activity will appear in the urine. The fraction is largely be determined by the amount of remnant and metastatic thyroid tissue. In most cases, 50-60% of the administered activity is excreted in the first 24 hours, and around 85% over a stay of 4-5 days. This represents a significant potential for radioactive contamination due to the large amount of activity excreted by the patient during hospitalization, contamination hazard may arise from I(131) via urine, saliva and perspiration and potential vomitus. The excretion would results in the possibility of contamination of the patient's environment and of inadvertent ingestion by other persons radioactive contamination is described as the contamination of any material, surface or environment or of any person, including both external skin contamination and internal contamination irrespective of the method of intake, by any radioactive material, nuclear material or prescribed substance. The contamination risk to the relatives of patients and community members through external rays and body fluids from patients in the treatment of radioactive iodine is an important issue that needs to be considered ,precautions should be taken to limit the radiation exposure of the nuclear medicine physician, nursing personnel, the patient's family, and members of the public with whom a treated patient may come in contact. These precautions vary among countries, but recommendations are usually based on measurement of I(131) retention or instantaneous dose rates, The European Union (EU) states that treatment of thyroid cancer using radioiodine I(131)should only be performed on inpatients and the patient must be hospitalized for at least 48 hours (- HamizahNMZ,et al 2012).

2.7.Technique:

Administered activity to patient , took the data (activity, time of administer activity) and entered to the Monte Carlo soft ware and analyzed in the soft ware according to equation $H=N_s*DF(T—S)$,calculated the organ doses and effective doses to the organs

H:total dose equivalent to target region T (rem or Sv).

N:= number of disintegrations that occurred in source region S.

Df:DF is the Dose Factor for source region S irradiating target region T

2.8.Brevious studies:

2.8.1.DaryoushShahbazi-Gahrouei, Saba Ayat1, Determination of Organ Doses in

Radioiodine Therapy using Monte Carlo Simulation, 2015, The absorbed dose obtained by Monte Carlo simulations for 100, 150 and 175 mCi administered 131I was found to be 388.0, 427.9 and 444.8 cGy for thyroid, 208.7, 230.1 and 239.3 cGy for sternum and 272.1, 299.9 and 312.1 cGy for cervical vertebrae.

2.8.2.HelioYoriyaz and Maria lnesCalilCuryGuimaraes,Montecarlo Simulation for dose determination in thyroid cancer patient,2002,the correlation between dose receive by Monte Caro for spine (bone marrow included) and dose recive by TLD dosemetery is S-value ,the average S-value in TLD dosemetry is 6.18E-07mGY\MBq.s and for bone marrow is 2.79E-05mGY\MBq.s

2.8.3.Vesna Spasic Jokic1, Marina Zdraveska Kocovska2,Olivija V askova2, Risk assessment in quality assurance programme nuclear medicine using radioiodine,2012, activity administered is 2000 MBq and the the Effective doses in selected organs are (269.2, 300.6 x10-5, 508.6, 310.8 x10-2, 163.8x10-2, 260.0, 71.8 x10-2, 40162.2)

2.8.4.Yuni K. Dewaraja, PhD1, Scott J. Wilderman, PhD1, MichaelLjungberg, PhD2, Kenneth F.Koral, PhD1, Kenneth Zasadny, PhD3, and Mark S. Kaminiski, MD4, Accurate Dosimetry in 131I Radionuclide Therapy Using PatientSpecific, 3-Dimensional Methods foSPECTReconstructionandAbsorbed Dose Calculation, 2005,the result they were found are the accuracy of the SPECT-based absorbed dose estimates in the phantom was >12% for targets down to 16 mL and up to 35% for the smallest 7-mL tumor. To improve accuracyin the smallest tumor, more OSEM iterations may be needed. The relative SD from multiplerealizations was <3% for all targets except for the smallest tumor. For the patient, the mean tumorabsorbed dose estimate from the new Monte Carl calculation was 7% higher than that fromconventionaldosimitry

2.8.5.VesnaSpasicJokica,⇑, Marina ZdraveskaKocovska,b, New technique for effective dose estimation using Monte Carlo simulation for the patients undergoing radioiodine therapy,2013,the result founded he effective doses were between 9.17 nSv (for bone surface) to 122.4 mSv (for stomach). As the total dose is estimated to be 126.73 mSv it is obvious that the highest part is received by stomach.

2.8.6.S.A.Natouh,Calculation radiation dose from a cloud of radioactive iodine using voxel phantom and montecarlo method,2009, , The absorbed dose obtained by Monte Carlo simulationswas found to be 3.444nGY for gonads,2.719nGY for bone marrow,2.549nGY for colon,2.997nGY for lung,2.375nGY for stomach,3,661nGY for bladder,2.819nGY for liver,2.997nGY for oesophagus,9.965 nGY for thyroid,4.183 nGY for skin,4.341 nGY for bone surfsce10.737 nGY for adrenals,3.999 nGY for brain,2.336 nGY for upper larg int,2.359 nGY for small intestine,3.219 nGY for kidney,3.520 nGY for muscle,4.90 nGY for Pancreas,3.060 nGY for spleen,9.522 nGY for eye lensand the accumulated

effective dose recive by person living in exposure area for 3 months due to aquantity of iodine 131 release into the environment at 45GBq is 3.4nano Sv

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chapter(3)

Material and method

Chapter three

Materials and methods:

3.1.Materials:

This study was done in Radiation & Isotopes Center of Khartoum (RICK),For 30 patients ,the age rang from 25 to 62,the weight range from 43 to 110 and the hight range from 140 to 184

3.1.1.Machine

3.1.1.1.Survey meter:

Radiation detector beta above 1 MeV , gamma above 25 KeV ,operating ranges 0 to 500 μR/hr or 0 to 5 R/h (0 to 50 mSv/h) Accuracy ± 10% of reading between 10% and 100% of full-scale indication on any range, exclusive of energy response (calibration source is 137Cs)

3.1.1.2.Mathematical phantom(Alderson radiation therapy phantom (ART)):

The male ART represents a 175 cm (5 ft. 9 in.) tall, 73.5 kg (162 lb.) male, and the female ART represents a 155 cm (5 ft. 1 in.) tall, 50 kg (110 lb.) female, The ART phantom is transected-horizontally into 2.5 cm thick slices. Each slice has holes which are plugged with bone-equivalent, soft-tissue-equivalent or lung tissue equivalent pins which can be replaced by TLD holder pins. The holder pins are ordered separately, Soft-tissue-equivalent coatings produce slices with glass smooth interfaces. These coatings are cut away over the air spaces of the oronasal pharynges, trachea and stem bronchi. Dosimitry holes are drilled in grids 3 cm x 3

]cm or 1.5 cm x 1.5 cm in 5 and 7 mm diameters. These afford detailed measurements of dose distributions.

3.1.1.3.Montcarlo simulation(VMC):

VMC can be considered a “specialized” Monte Carlo program as it is designed specifically to solve radiation protection problems, and the main geometry used is the matrix, matrices containing two or more anthropomorphic phantoms and special geometries for source tissues, such as the endosteum/cortical bone interface may be simulated ,the development of Visual Monte Carlo (VMC) started in 1992 at the Instituto de Radioproteção e Dosimetria, VMC dose calculation, for dose calculations due to exposure to radionuclides or X-rays ,VMC began as a solution to the problem o f photon transport through phantoms representing the human body, followed by the detection of the photons leaving the human body(.(Latin American IRPA Regional Congress on Radiation Protection and Safety - IRPA 2013)).

3.2.Methods:

3.2.1 Patient samples:

A total of 30 patients were examined in Radiation & Isotopes Center of Khartoum (RICK). The data were collected using a data sheet for every patient in order to maintain consistency of the information.The following parameters weight, height, age ,activity , and organ dose were recorded.

3.2.2. Patient preparation:

Patients isolated at isolating rooms in Radiation & Isotopes Center of Khartoum (RICK) ,administered I131 (50,100,120,150,200)mci, by oral then gave them the orders like drink a lotof water ,a lot of shoring ,never turns around the area they found in it and never keep in touch with their family longer time ,just their family get them their special requirement , daily took dose reading about 1m from thyroid to ensure that the activity slow down ,that about 5 days they isolated , let them go home after five days , took administered activities which represented entering data to Monte Carlo soft ward ,exposure time for five day they found then calculated internal doses , effective doses from internal source I131, analyzed by Microsoft excel and drew a graph between (dose and exposure time) finally compared the internal doses with their reference level from ICRP.

3.2.3. Absorbed Dose calculations:

Visual Monte Carlo dose calculation:

VMC dose calculation allows Monte Carlo calculations to be performed for exposure to photon fields generated by radionuclides .

Tissue equivalent dose to each radiosensitive organ as defined in the ICRP 103 recommendation and also allows isodose curves to be established in the region close to the source, The Visual Monte Carlo code used to calculate organ and effective doses delivered by target-source irradiation geometries associated with radioiodine therapy treatments, when a patient was accompanied during hospitalization , This simulation study showed that, in the 3 situations considered, the total effective dose to an individual in normal contact with the patient was less than 0.85 mSv for up to 11.1 GBq (300 mCi) of administered activity. The results of this study suggest that for these patients receiving radioiodine therapy, radiation protection procedures after hospital discharge are unnecessary.(Latin American IRPA Regional Congress on Radiation Protection and Safety - IRPA 2013)

Chapter four

Result

Chapter four

4.Result:

The results are divided to six groups of 50,100, 120,150,180 and 200 mCi that is based on the therapeutic dose administrated to patients. Table (4-1) summarizes the Age-Weight-High of patient ,Table (4-2) summarizes the results of absorbed doses of photons, calculated by Monte Carlo and Table (4-3)summarize the results of activity obtain by survey meter.

Table (4-1):Shows Age\year,Weight\Kgandhight\cmof the patient

	Group1(50 mci)	*Group1(100mci*	*Group1(120mci*	*Group1(150mci*	*Group1(180mci*	*Group1(200mci*
Age Range	*50*	*25-80*	*47*	*35-62*	*59*	*36-45*
WeightRange	*74.7*	*43-110*	*84*	*53-60*	*107*	*45-76*
HighRange	*169*	*140-180*	*184*	*155-165*	*155*	*150-160*

Table (4-2):Shows results of MC simulation (GY)

Organ	*Group1(50 mci)*	*Group1(100mci*	*Group1(120mci*	*Group1(150mci*	*Group1(180mci*	*Group1(200mci*
Bone marrow	*0.22*	*0.45*	*0.54*	*0.67*	*0.81*	*0.90*
Colon	*0.04*	*0.09*	*0.10*	*0.13*	*0.15*	*0.17*
Lung(10^{-9}*)*	*0.97*	*1.93*	*2.32*	*2.90*	*3.48*	*3.87*
Stomach	*0.14*	*0.29*	*0.34*	*0.43*	*0.52*	*0.57*
Breast	-	-	-	-	-	-
Remainder	*0.74*	*1.47*	*1.77*	*2.21*	*2.65*	*2.94*
Gonads	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Bladder	*0.00*	*0.01*	*0.01*	*0.01*	*0.02*	*0.02*
esophagus	*5.01*	*10.01*	*12.01*	*15.01*	*18.02*	*20.02*
Liver	*0.15*	*0.29*	*0.35*	*0.44*	*0.53*	*0.59*
Thyroid(10^{-3}*)*	*189.97*	*387.94*	*455.96*	*426.93*	*683.92*	*759.93*
Bone surface	*0.33*	*0.66*	*0.79*	*0.99*	*1.19*	*1.32*
Brain	*0.08*	*0.16*	*0.19*	*0.24*	*0.29*	*0.32*
Slivary gland	*2.54*	*5.09*	*6.10*	*7.63*	*9.15*	*10.17*
Skin	*0.09*	*0.17*	*0.21*	*0.26*	*0.31*	*0.35*
E	*8.90*	*17.80*	*21.36*	*26.69*	*32.04*	*35.59*

MC:Monte Carlo

E:Effective dose

Tabe (4-3): Shows the mean activity obtain by use survey meter

Activity Administrated	*group1 (50mci)*	*Groub2 (100mci)*	*Group3 (120mci)*	*Group4 (150mci)*	*Group5 (180mci)*	*Group6 (200mci)*
Mean activity(µsv) of thyroid	*68.35*	*48.91*	*18.71*	*10.13*	*4.98*	*1.6*

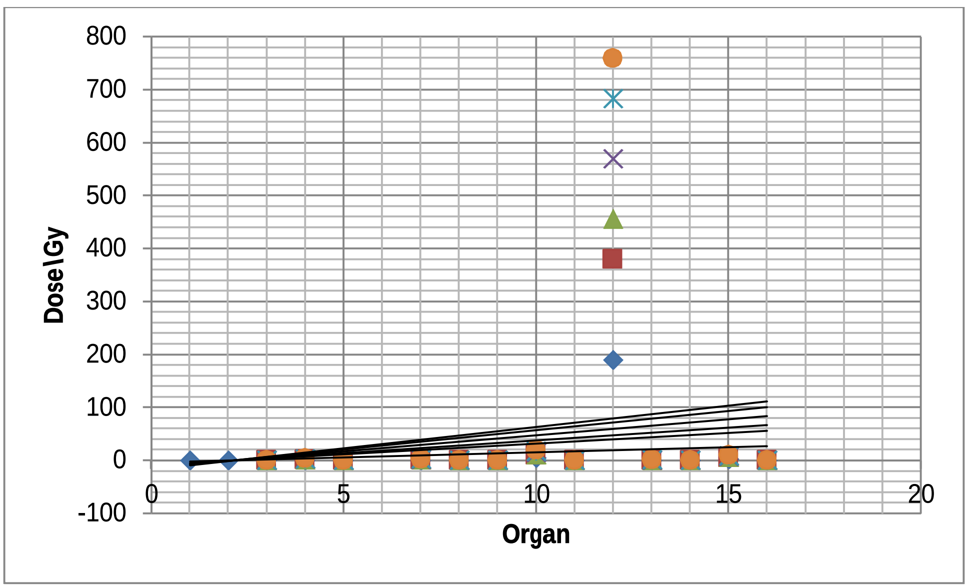

FIG.4.1. Comparison between different types of organ and absorbed dose from Monte Carlo simulation

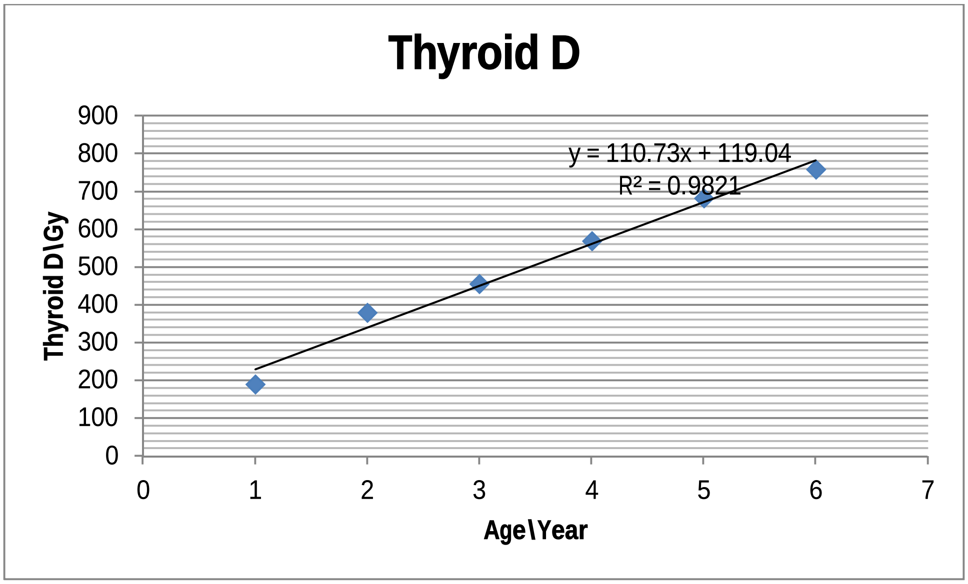

FIG.4.2.Comparison between the age of different Thyroid patient and Thyroid Dose

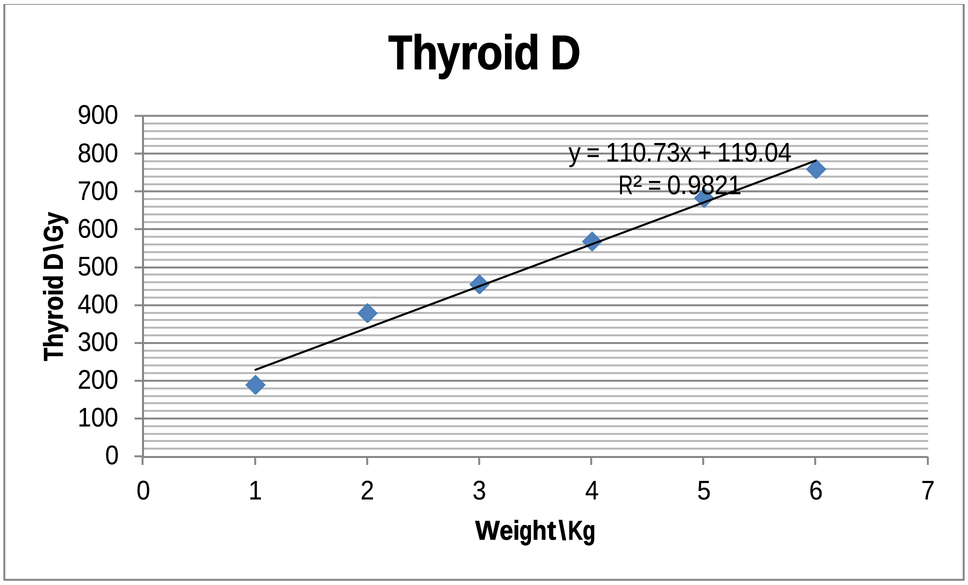

FIG.4.3.Comparison between the Weight of different Thyroid patient and Thyroid Dose

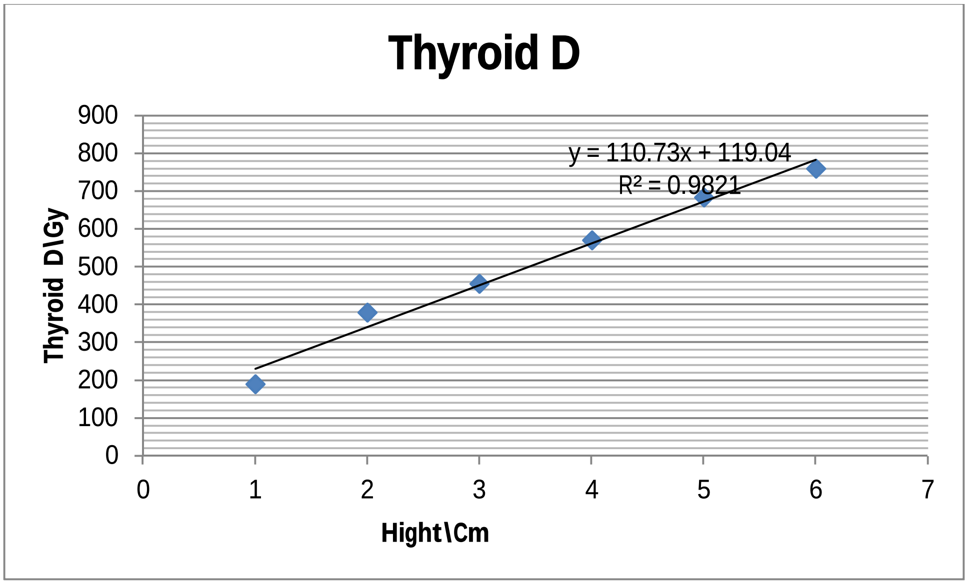

FIG.4.4.Comparison between the Hight of different Thyroid patient and Thyroid Dose

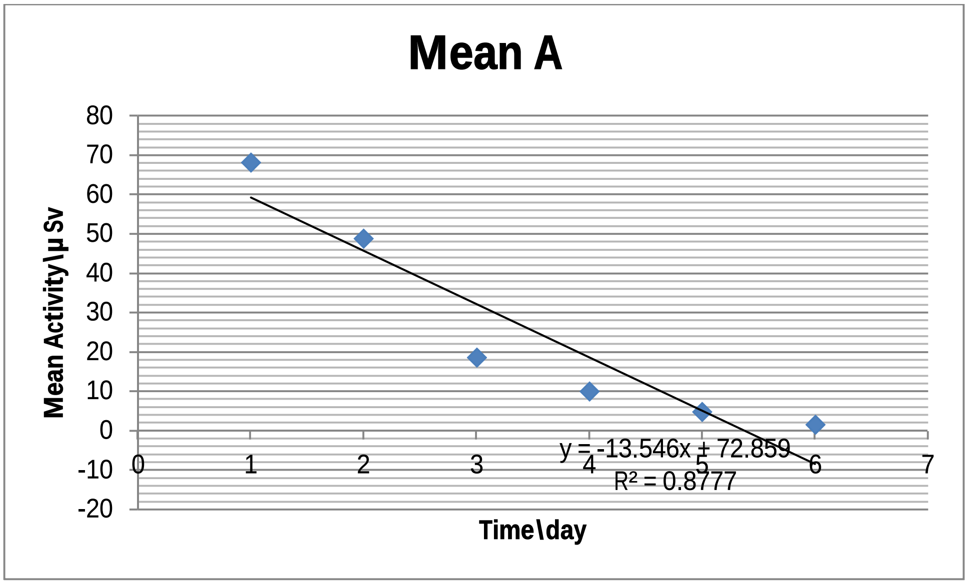

FIG.4.5.Relationship between the time\ day and mean activity At 1m from Thyroid patient

Chapter Five

Discussion, Conclusion and Recommendations

Chapter Five

Discussion, Conclusion and Recommendations

5.1.Dissection:

Internal radiation dosimetry of radiopharmaceuticals is an important aspect of nuclear medicine to weigh risk versus benefit considerations. However, since implantation of many dosimeters in the human body is undesirable (or impossible), the doses of internal organs are not measurable and some dose calculation has to be applied.Monte Carlo techniques have been used, Comparing the results of absorbed doses of organs obtained by Monte Carlo with ICRP and (EugenGurzau et al, MD; Sam Keith et al), it's obvious that there's no significant difference between the results of (bone marrow,lung,brain,bladder,iver,stomach) of Monte Caro , ICRP and (EugenGurzau et al, MD; Sam Keith et al))and there is significant differencein the other because Monte Carlo based on reference human data, and this could be a source of error in estimation of absorbed doses of different patients, On the other hand, the accuracy of absorbed dose of internally distributed radiopharmaceuticals estimated by the Monte Carlo method depends on the cumulated activity of the source organs and their mass The thyroid has the greatest amount of absorbed dose387.94cGY and 426.93cGYas same result achive byDaryoushShahbazi-Gahrouei, Saba Ayat1 and for lung the result was 2.3nGY as same result achive byS.A.Natouh. Absorbed doses in studied organs will be decrease as the administrated activity decreases.

The data such as patient age, weight, height are show linear relationship with thyroid dose , The weight of the patients ranges from 43 t0 110 Kg, The maximum absorbed dose recorded is 759.93Gy at wight from 45 to 76; may be attributed to the patients' high and age which were also high .In this survey the avtivity (A) decrease with time according to relationship $A = A_0 e^{-\lambda t}$

5.2.Conclusion:

This study was intended the measurement of internal Radiation dose during Thyroid Cancer by Iodine 131 by Monte Carlo simulation in Radiation & Isotopes Center of Khartoum (RICK)to help in applying radiation protection procedure of the patient. The most of the estimated internal organ dose values were within the range of reference level and out the range at some previous studies .The, Patient radiation dose is a very important parameter to maintained internal radiation dose within tolerance level as with in the guidance. Dose survey helps to ensure the best possible protection of the patient ,the study show that the max dose from(bone marrow was 0.90GY,skin was 0.35GY,sivary gland 10.17,brain 0.32GY,bone surface 1.32GY,thyroid 759.93mGY,liver 0.59GY,esophagus 20.2GY,bladder 0.02GY, remander 2.94GY,stomach 0.57GY,lung 3.87nGY,colon 0.17GY.

5.3.Recommendations :

Patient radiation dose should be survey to insure the dose slow down to acceptable level before let him leave the hospital

Patient should be learn the orders like drink much of water to ensure the dose slow down

The physicist should be careful when treat with patient and treated the patient in quickly carefully and weare shield clothes and dot let co patient or every one treat with patient directly and more than 5 minute

Patient should be isolate 5 day in special rom and not mixed with other people ,in any case of problem patient should be tell the doctor or staff

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Visual Monte Carlo Code: