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THE EFFECT OF RADIATION ON THE TYROSINE SYSTEMS OF THE THYROID GLAND

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Abstract
The thyroid takes iodine from blood circulation and absorbs it. The thyroid gland will absorb both stable (normal) and radioactive iodine since it is unable to distinguish between them. The thyroid gland is one of the most radiation-sensitive areas of the body in newborns and children. The most common treatment for thyroid cancer is radiotherapy. The goal of this study was to determine the thyroid gland's absorbed dose. The link between the absorbed dosage and thyroid hormone levels was also investigated. The mean thyroid dose was 2600 rad. Thyroid hormone levels did not alter significantly between pre-radiotherapy and post-radiotherapy. Increased thyroid absorbed dose and variations in TSH had a strong association. There was no evidence of a link between thyroid malfunction and age, gender, or chemotherapy treatment.

Keywords: cancer, radiotherapy, thyroid gland, TSH, X-rays

Methods:
120 thyroid cancer patients, aged 16 years old or younger, undergoing external radiotherapy were studied. Based on measurements in four patients, Radiation Effects 120 Pediatric included 24 participants who were exposed to less than 2000 rads (average 2600 rads) and 96 people who were exposed to more than 2600 rads (average 4400 rads) and the actual dose absorbed by the thyroid gland was less than the maximum dose of 2596 rads. Thyroid-stimulating hormone (TSH) was measured before and after the radiotherapy. In the low-dose group, thyroid dysfunction was documented at a median outcome of 18 months; in the high-dose group, it was documented at a median outcome of 31 months.

Introduction
Being one of the body's most radiation-sensitive organs, the thyroid gland is significantly impacted by radiation. Examples of these rays are X-rays, rays resulting from nuclear reactions, ionizing radiation, and also radioactive iodine.

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The reason for the great effect of radioactive iodine on the thyroid gland is due to the high rate of absorption of iodine in the blood by the thyroid gland and its inability to distinguish between natural iodine and radioactive iodine, for this reason, the gland absorbs this radiation from the blood of a person originally exposed to radioactive iodine.

The most age groups at risk of radiation are children, with a higher percentage than adults, if the thyroid gland is full of natural iodine, that is, there is a sufficient amount of iodine in the human diet and the thyroid gland is filled with iodine that it originally needs, so we have reduced the risks of radioactive iodine after exposure to it, it is reported that the inhabitants of the area around Chernobyl were suffering from severe iodine deficiency, and this affected them greatly.

Many diseases can be caused by exposure to the thyroid gland, including the decreased activity of the thyroid gland, thyroid nodules, and thyroid.

The thyroid gland is a type of endocrine gland. It is found throughout the body and secretes its hormones directly into the bloodstream. It has a large and essential role in the various functions of the body (Cardis E., 2007), such as:

- growth.
- movement.
- reproductive processes.
- metabolic processes.

It consists of eleven glands in the body of men and women, except for two:

- The ovaries.
- The testicles.

The thyroid gland is classified as one of the most prominent endocrine glands and consists of two lobes, located in the anterior part of the neck. (Cardis E., 2007)

In its lining are cystic cells, which are responsible for secreting thyroid hormones (M, 1972).

Among the most important problems that may affect the thyroid gland as a result of a defect in its functions:

Excessive growth of the gland (as a result of the gland producing too much of its hormones) (Slanina J, 1977).

This disease has many symptoms that may conflict with other diseases, which is why it is usually difficult to diagnose this disease by doctors. We mention among these symptoms (Slanina J, 1977):

- If your appetite and food intake remain the same or increase, you may lose weight unintentionally

- fastest heartbeats (tachycardia) — usually more than 100 beats per minute
- Heart arrhythmia (arrhythmia)
- Heart pounding forcefully (heart palpitations)
- Binge eating
- Nervousness, anxiety, and irritability
- Shivering — there is usually a slight tremor in your hands and fingers
- sweating

Hypothyroidism (as a result of the gland's inactivity and to secrete hormones sufficiently) (Shalet SM, 1977).

The primary function of the thyroid gland is the secretion of hormones (thyroxine and triiodothyronine).

Symptoms of this disease range from the percentage of hormones that the gland has refrained from producing, and the years usually pass since the discovery of this disease, we mention among these symptoms (Shalet SM, 1977):

- Tired
- High cholesterol in the blood
- -Muscle pain, stiffness, or aches
- Dry skin
- Constipation
- Dry skin - Overweight
- Swollen face - Hoarseness
- Reduced ability to think clearly
- Acute episode of cold sensitivity Menstruation more than usual or irregular periods
- hair loss
- slow heart rate
- Depression
- Poor memory
- Enlarged thyroid gland (goiter)

Thyroid hormone functions (Nelson DF, 1980)

- Providing energy and heat to the cells of the body to regulate many functions of the body.
- An important role in physical and sexual growth (where a deficiency in the secretion of its hormones causes a noticeable delay in growth).
-

- Regulate the work of the digestive system and metabolic processes.
- It increases the heart rate and pumps blood, which leads to the expansion of blood vessels, which causes blood to reach many organs of the body.

Literature Review

Here we try to give a brief overview of previous research that was done by previous researchers. we discuss thyroxine suppressive therapy in patients with nodular thyroid disease.in fact, Gharib, H., and his colleague Mazzaferri, E. L. in 1998 studied evidence about thyroxine suppressive therapy in patients with thyroid nodules, covering the clinical importance and natural history of nodules and the effects and potential side effects of thyroxine therapy.

They found that patients with cytologically benign nodules should be followed without thyroxine medication after conducting trials, sampling, and conducting research procedures. When followed for a long time, most benign nodules maintain their size and remain benign. If a nodule grows in size, a biopsy should be performed again, or surgery should be performed.

Radiation-induced thyroiditis (Schimpff SC, 1980)

The thyroid gland is highly sensitive to all types of radiation and among the types of ionizing radiation such as:

- X-rays.
- The radiation from nuclear fission is used to produce energy.
- In addition to radioactive iodine (I-131).

Radiation exposure can also cause various thyroid gland diseases, including hypothyroidism, thyroid nodules, and thyroid cancer.

In addition to d inability some genetic diseases, radiation exposure is currently the main and only cause of thyroid cancer.

Note that the minimum amount of radiation that may lead to thyroid disease has not been reached.

Radioactive iodine is also used to treat hyperthyroidism and thyroid cancer.

The dose received by people receiving treatment for thyroid cancer is usually only 50 to 150 gray (Green DM)

People are exposed to "radioactive iodine" as part of an atomic scanning test between 0.5 and 1.5 gray. Some people who lived through the Chornobyl reactor accident and some survivors of the explosion of the Hiroshima and Nagasaki bombs were also exposed to much more radiation.

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Children were also exposed to an amount of radiation estimated at 50 grays as a result of the Chornobyl accident, which increased the risk of thyroid cancer.
Children are the most vulnerable to radiation, and people who suffer from iodine deficiency are more likely to develop a disease resulting from radiation exposure. (Green DM)
The more iodine we get from eating iodine-rich foods, the more iodine the thyroid gland will not absorb as much radioactive iodine if exposed to it. (Brenner D.J., 2003)
It is known that taking potassium iodide supplements before or immediately after a nuclear accident will significantly reduce the risk of thyroid cancer.(Fig.1)

Chemical formula	**C9H11NO3**
Molar mass	181.191 g·mol^{-1}
Solubility in water	0453g/100 ml
Magnetic susceptibility (x)	-105.3*10^{-6} cm^3/mol

Fig. 1(a): Chemical properties of Tyrosine enzyme

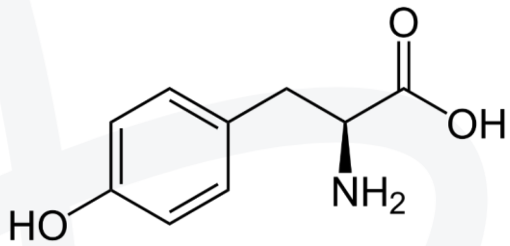

Fig. 1(b): Tyrosine enzyme

It is a very important hormone for humans, and it is considered one of the amino acids and is found in many proteins. You must eat food that contains tyrosine in an amount not less than 33 milligrams per kilogram of human weight. Tyrosine is found in many foods such as meat Cows fish and chicken meat. (Brenner D.J., 2003).
Tyrosine is converted in brain cells that secrete dopamine by the enzyme TH tyrosine hydroxylase to levodopa. Tyrosine hydroxylase is a component of the neurotransmitter dopamine and determines the speed of this reaction. (Schimpff SC, 1980) Thus dopamine can be converted to noradrenaline and epinephrine in the adrenal gland (the suprarenal gland);

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They work to increase the heartbeat and constriction of blood vessels, and in general, lead the body to prepare for cases of escape or conflict in the event of sudden danger. Children are the most vulnerable to radiation, and people who suffer from iodine deficiency are more.

Discussion:

Radiographic quantities and effects on some our samples in children as below:

	Low Dose			High Dose		
	Entire Group	$TSH < 10\ \mu U/ml$	$TSH \geq 10\ \mu U/ml$	Entire Group	$TSH < 0\ \mu mll$	$TSH \geq 10\ \mu mll$
Total	29	21	5	96	21	72~~71~~
Sex: Male	20	17	3	46	7	38
Sex: Female	9	4	2	50	1~~3~~	34
Age (Mean. Years)	10.4	10.5	9.9	13.3	12.9	13.4
Radiation Dose (rad)+: mean	22000	2000	2200	4400	4300	44600
Radiation dose (rad)+: Range	1500 – 2600	1500 – 2600	2000-2550	3200-6000	3200-4500	3450-6000

Table 1: Patients and their treatment doses

Thyroid function is measured in 120 children aged 16 and younger after radiation (XRT) for Hodgkin's disease. We discovered that four of the twenty-four children (16%) who received 2000 rads or more in the cervical region, including the thyroid, had thyroid abnormalities. Thyroid abnormalities were found in 74 of 95 patients (80%) with more than 2200 rads. With the exception of three cases (one with hyperthyroidism and two with thyroid nodules), we link the anomaly to the development of elevated levels of thyroid-stimulating hormone (TSH). There was no evidence of a link between thyroid malfunction and age, gender, or chemotherapy treatment. In none of the youngsters, the LAG-XRT interval was linked to thyroid impairment. Thyroid dysfunction was detected in the low-dose group at a median of 19 months, and in the high-dose group at a median of 31 months, with most people becoming abnormal between 3 and 6 years after radiotherapy. The spontaneous return of thyroid-stimulating hormone (TSH) to normal limits in 20 children and considerable improvement in 7 of them verifies the incidence of dose-related hypothyroidism in children after exposure to external radiation to the neck in this investigation.

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Practical Part Results

We study Radiation Effects on 120 pediatrics including 24 participants who were exposed to less than 2000 rads (average 2600 rads) and 96 people who were exposed to more than 2600 rads (average 4400 rads) (Table 1). Based on our measurements in four patients, the actual dose absorbed by the thyroid gland was less than the maximum dose of 2597 rads._ It had a 64.13 percent value in the isthmus, an 86.88 percent central surface radiation dose at 2 cm, and a 97.7 percent central surface radiation dose at 4 cm outside the center line. Because the typical thyroid dosage was extremely comparable to the dose provided The revision was not taken into account in the data that followed. Four of the twenty-four children (16%) who got 2600 rad or less Radiation Effects 120 Pediatric included 24 participants who were exposed to less than 2000 rads (average 2600 rads) and 96 people who were exposed to more than 2600 rads (average 4300 rads) (Table1). Based on measurements in four patients, the actual dose absorbed by the thyroid gland was less than the maximum dose of 2597 rads. (Fig.1,2)

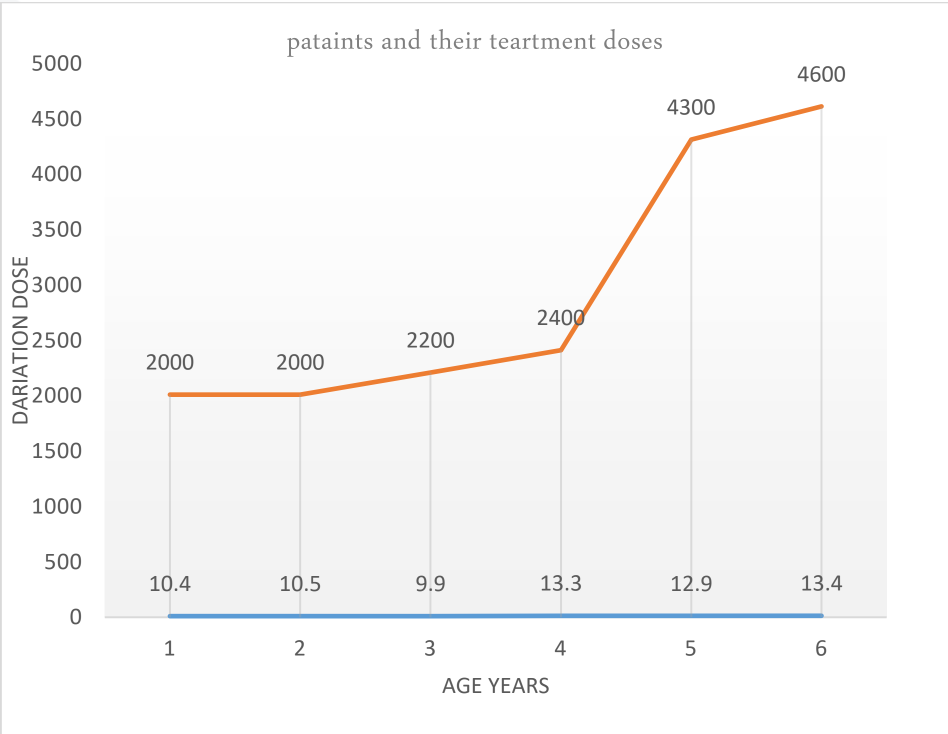

Fig.1: Given Dose vs. Age

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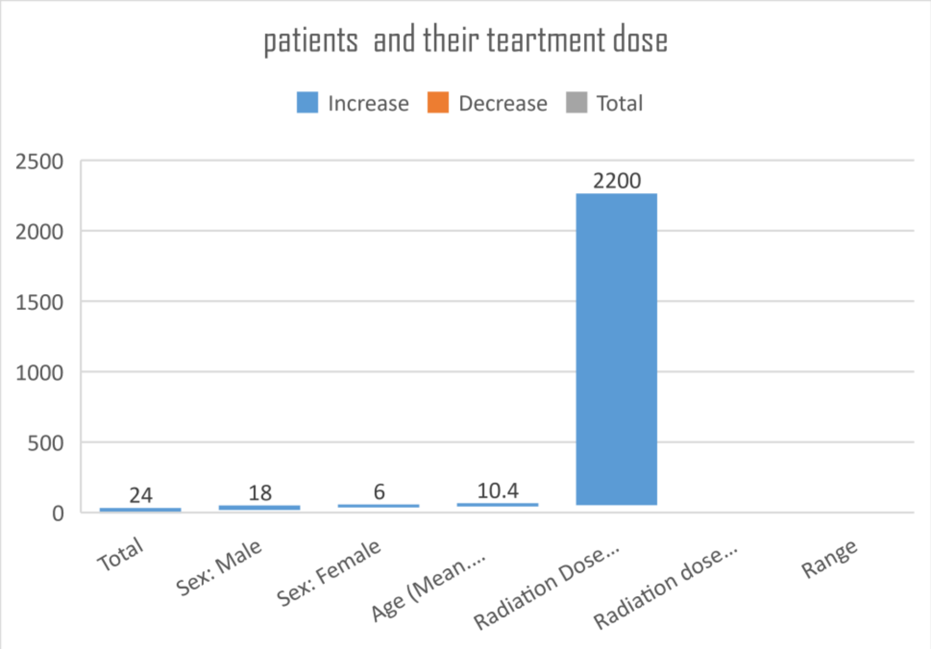

Fig.2: Distribution of Dose

TSH levels were increased in 72 of 96 children (74%) who got more than 2600 rad. Clinically hypothesis diagnoses of children were made using high system groupings. 26% of those in the high dosage group had low serum toxin mirrors and a high ramp. In low-sake stone thyroid or EUTHYROID (9.9 years old or older version), the average age was not significant. 9 years (Table 1). TSH levels were raised in the sexual secretions of 78 percent of men and 7.1 percent of women in the high-dose group (p = 0.62).

Thyroid function testing The TSH peak was independent of the onset of irradiation, according to linear regression analysis. A 16-year-old man treated with 4400 rad acquired hyperthyroidism after irradiation, while a 5-year-old girl had Graves hyperthyroidism. Excluding one patient with hyperthyroidism and two normal thyroid patients with thyroid nodules, maximum TSH test levels were plotted versus radiation exposure. The regression line's slope is 0.26, which is significantly different from zero in (P = 0.002). The double dose corresponding to the geometric mean peak TSH is 1100 radians. Peak TSH was gender-independent (P> 0.47). Therefore, there is no significant difference between the incidence and degree of abnormality associated with gender. Chemotherapy Effects All patients were treated with chemotherapy. In high dosage groups, 54% with increased TSH values with normal TSH values increased 52% (p = 0.23). In the abnormal high dose group of one child, peak TSH was also irrelevant to the management of drug treatment (P> 0.52).

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A focus of carcinoma was found in up to 14-year-old girls who received 4600 rads, 10 years after treatment. An 8-year-old child who received 4000 radians was the second patient with nodes. His thyroid function was normal. The third nodule was found in a 10-year-old child with hypothyroidism who had been given 4360 rad when the nodule was identified. Characteristics of TSH Test Intervals In low-dose children, the average period between irradiation and the first TSH test was 1.3 years, whereas the average time between the last TSH test was 2.9 years. It takes an average of 1.5 years from the first abnormal TSH test to the next abnormal TSH test. In the low-dose group, the interval between irradiation and the first TSH test was 2.7 years, while in the high-dose group, the time between the last TSH test was 6.2 years. On average, it took 2.6 years for the first abnormal TSH test. TSH readings were taken more frequently in the low dosage group than in the younger children treated, which explains the shorter intervals. In the high-dose group, TSH levels were discovered in 14 percent of patients after one year, 46 percent after two years, 73 percent after three years, and 89 percent after five years. The most accurate anomaly tests are usually discovered 8 to 9 months following the initial anomaly test. The regression line has a slope of 0.444 in 0.442, and P = 0. 0444, when the peak TSH value is plotted against the period of irradiation to the detection of the high dosage abnormal group. As a result, patients who were further away from the largest anomaly displayed anomalies of degrees lower than. Because the initial test was not performed in certain situations, the patient's greatest abnormality may not have been detected. 6.8 (33 percent) of the 21 normal patients in the high-dose group were examined for the first time at least seven years following irradiation.

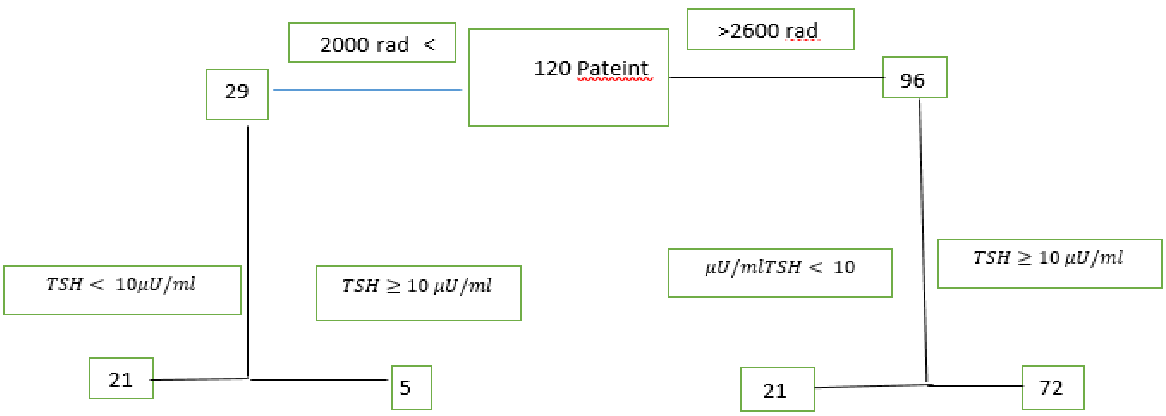

Fig.4 : Final study plan

Conclusion:

According to our findings, the thyroid's absorbed dose can affect its function. As a result, in radiation, the thyroid gland should be regarded an organ at risk. There was no evidence of a link between thyroid malfunction and age, gender, or chemotherapy treatment. Between 3 and 5 years after radiotherapy, the majority of people have abnormalities.

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