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The effect of radiation on thyroid gland

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Abstract
Radiation emitted from sources that are transmitted through an intermediated medium and absorbed by animal body. Radiation is very high up environmental toxin. Many sources of radiations are mobile phone, computer, UV lamp and torches radiation affected animal's body organs such as thyroid gland, liver, kidney, etc. Radiations cause oxidative stress and generate free radicals such as hydroxyl radical, superoxide, nitric oxide, hydrogen peroxide radicals etc. These free radicals are unstable and chemically very active acting as an oxidizing agent that causes the morphological and physiological changes in the cells. In thyroid cells, these radicals can contact the other macromolecules and increase to changes in their structure and functions and hypo or hyperthyroidism conditions. An antioxidant our well wisher of damaging cells. Antioxidants inhibit the generation of free radicals and protect the cells. Antioxidants are essential for many enzymatic reactions and also acts as a free radical scavenger.

Keywords: radiation, thyroid gland, oxidative stress, antioxidants

1. Introduction

People are affected by radiation from different sources. Energy emitted from a source that is transmitted through an intermediate medium and absorbed by the animal body. Radiation is very high up environmental toxin and transmission of energy in the form of particles or waves through sources. Radiation impression of the ionizing and non-ionizing radiation. Even though ionizing and non-ionizing radiation has been used extensively in the many sources such as a mercury lamp, dental polymerizing equipment, X-rays machine, black light lamp, welding equipment, counterfeit currency detectors, etc. Consequently, radiation effect on the body organs such as the thyroid gland [1, 2], eyes [3], liver [4], skin [5]. The UV radiation is electromagnetic radiation and maximum generated from sunlight. UV radiation is a non-ionizing and classified into three types UV-C, UV-B & UV-A. UV-C (200-280 nm, shortwave) is lethal than UV-B (280-320nm, medium wave). It causes skin darkening and erythema, the skin cancer possibility increases from long exposure to UV-B, UV-A is non-lethal radiation (320-400 nm, long wave). UV radiation damage cells and produced free radicals. Ionizing radiations having high energy and short wavelength. It include X-rays, gamma rays, alpha and beta particles. Ionizing radiation has enough energy to generate ions. Which damage the cells, enzymes, protein and nucleic acid [6, 7, 8].

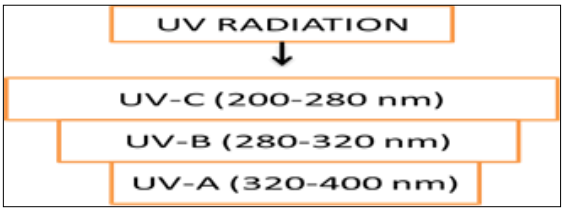

Fig 1: Types of UV Radiation

The thyroid gland is the largest endocrine gland and consists of two lobes beside the trachea and lowers the larynx. The thyroid gland secretes the thyroid hormones which influence the basal metabolic rate, protein synthesis and have a wide range of other effects including on the development, respectively. The thyroid hormones T3 and T4 are synthesized from iodine and tyrosine in follicle cells. The thyroid also produces calcitonin hormones; it plays a role in calcium homeostasis.

Radiation generates the oxidative stress, Oxidative stress founded when the imbalance between reactive oxygen species (ROS) and antioxidants and cells tried to work against the oxidant property and redox balance through the stimulation of defensive enzymes, proteins [9, 10]. Even though oxidative reactions arise in all tissues and organs, the thyroid gland mobilizes such an organ in which oxidative processes are essential for thyroid hormone synthesis. It is Putative that vast quantity of ROS, particularly of hydrogen peroxide (H_2O_2), are yield in the thyroid underneath physiological conditions. Yet, with extra oxidative misuse caused by ionizing radiation, improved damage to macromolecules occurs, potentially leading to different thyroid diseases, also, cancer involved [11].

Non-ionizing radiation shows noxious effect of the thyroid gland. This generates the free radicals. A radical is groups of molecule that containing one or more unpaired electrons [12]. Free radicals generated by our body from a different type of radiation. If free radicals extreme the body's capability to control them, a situation known as oxidative stress. Free radicals thus harmfully vary lipids, proteins, and DNA and generate a number of human diseases [13]. There are many types of radicals, but those of main concern in biological systems are derived from oxygen, it called reactive oxygen species. Superoxide anion, hydrogen peroxide, hydroxyl radical is also reactive oxygen species. The Modern growth in the information of free radicals and reactive oxygen species

(ROS) in biology is Procreating a medical revolution that promises a new age of health and disease administration [14]. Reactive oxygen species are also formed during the metabolism of oxygen.

The noxious effect of ionizing radiation in natural systems are mostly mediated through the generation of reactive oxygen species (ROS) in cells as a result of water radiolysis [15], render rise to OH^- and H^+ [8]. Ionizing radiation interacts with biological systems to encourage the extreme flow of free radicals that attack different cellular elements [16]. The effect of ionizing radiation on the thyroid is well recognized [17]. The pathophysiological description of radiation-induced thyroid damage is related to inhibition of follicular epithelial function and subsequent progressive alteration of the endothelium, the effect increases by time [18, 19]. The possibility of thyroid carcinoma after exposure to radiation doses higher than 0.05 - 0.1 Gy is higher in younger children at the time of exposure and all efforts should be performed to avoid some radiation exposure during childhood [20]. Several thyroid abnormalities may be caused by radiation exposure [21].

Reactive oxygen species (ROS) together with partially reduced forms of oxygen i.e. superoxide anion, hydrogen peroxide and hydroxyl radical as well as organic counterparts such as lipid peroxides are produced as natural consequences of oxidative cell metabolism. Under physiological conditions, ROS [22] generation is controlled by a large number of anti-free radical systems which act as protective mechanisms. These systems consist of antioxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase, and glutathione reductase as well as non-enzymatic antioxidants, among which the most important vitamins C and E, carotenoids, and glutathione. Interruption of the antioxidant stability results since the increased generation of ROS, inactivation of detoxification systems, or excessive exploitation of antioxidants. The disturbance is a causative factor in the oxidative damage of cellular structures and molecules such as lipids, proteins, and nucleic acids [23].

The aim of present reviewed the effect of UV-radiation on the thyroid gland and their oxidative effect of rats, the study of preventive effects of antioxidant on rat thyroid activities.

2. Radiations

Radiations are an energy source, transmitted through a source have sufficient energy to penetrate living and non-living cells. Radiations are found in many forms and affected by the natural environment and yield through recent technology. Mostly radiations have the potential for both effects positive and negative. Radiation-induced damage might result in adverse health effects within hours to weeks and delayed effects may be observable many months after exposure [4]. Even though sunlight very essential radiation of the entire can be detrimental in extreme amounts. Basically, radiation classified into two categories ionizing and non-ionizing. Ionizing and non-ionizing radiation exerts its effects on the thyroid gland, involving long-term damage cancer, both radiations mostly targeted of several genes, protein, lipids and cause cancer [24].

3. Thyroid and Ionizing Radiation

Ionizing radiation is not detected by any of our senses but can be easily detected by electronic equipment. Ionizing radiation is emitted by radioactive atoms. Its energy is high enough to damage our bodies. Actuality, Ionizing radiation energy in the form of waves or particles that has as much as a necessary force to eliminate electrons from atoms. The quantity of ionizing radiation that can be rendered to treat tumours are limited due to the nearby normal tissues and organs in the Proximity of a tumour that could be also exposed to the radiation causing damage [25]. In humans and animals, ionizing radiation may cause cancer, death, and failure of neural function and also stimulate mutation, chromosomal aberrations and apoptosis in cells [26, 27]. Ionizing radiation has enough energy to generate ions. Ionizing radiations damage the cells, enzymes, protein and nucleic acid [6, 7, 8].

He–Ne laser has a potential therapeutic performance to ameliorate the damaging effect of the ionizing radiation, which depends on the frequency of its application. Further studies with longer periods of treatment are recommended [28]. Even though oxidative reactions take place in all tissues and organs, the thyroid gland constitutes such an organ in which oxidative processes are indispensable for thyroid hormone synthesis. It is estimated that huge amount of reactive oxygen species, particularly of H2O2, are formed in the thyroid under the physiological situation. Yet, with additional oxidative mistreatment caused by IR, increased damage to macromolecules occurs, potentially leading to different thyroid diseases, cancer included [9].

4. Thyroid and Non-ionizing Radiation

Non-ionizing radiations are longer wavelength and low energy. This radiation included UV radiation, visible light, infrared; microwave, radiowave and these radiations are using a Computer monitor, photocopier machine, printers, and mercury lamps. Thyroid gland of rat exposed by exposure to 2.45 GHz radiation and obtained the glandular hypertrophy in relation to the SAR and changes of the distribution of HSP-90 linked with membranes and parafollicular cells and these effects might not be absolutely formed by radiation and the hypothalamus can be included with another indirect effect [29].

Table 1: Types of Non-Ionizing Radiation and their Wavelength

S. No	Non-Ionizing Radiation	Wavelength
1.	Ultraviolet	200-400nm
2.	Visible light	400-700nm
3.	Infrared	750nm-1m
4.	Microwave	1mm-1m
5.	Radiowave	1mm -100km

The thyroid gland is sensitive to EMF exposure and this exposure induced morphological changes with drop off in serum T4 and T3. These changes remained to the end of the experiment indicating that a longer period of time is required for the return of normal thyroid activity after EMF exposure. Besides, the results revealed significant improvement in the supervision of vitamin E through the exposure time [30].

5. Thyroid and UV Radiation

The UV radiations are major factors for set-up and development of UV-initiated disease and Sunburn. [31, 32] Prolonged exposure to solar-simulated UV irradiation leads to

gathering of free radicals in the skin [33], immune suppression and synthesis of excessive proinflammatory cytokines, all resulting in oxidative stress in different tissues [34, 35]. UV irradiation is known to induce apoptosis in many cell types [36, 37]. UV irradiation causes direct DNA damage (thymine dimers) and forms bulky adducts that cause structural distortion in the normal double-strand DNA backbone [38]. UV irradiation could also diminish the intracellular content of reduced glutathione [39] possibly through peroxidation of lipids, causing the production of free hydroxyl radicals and a state of oxidative stress in the cell; the resulting damage occurs in proteins, lipids, and DNA. UV radiation exerts its effects on the thyroid gland; involving long-term exposure radiations mostly target several genes, protein, lipids and causes cancer [21].

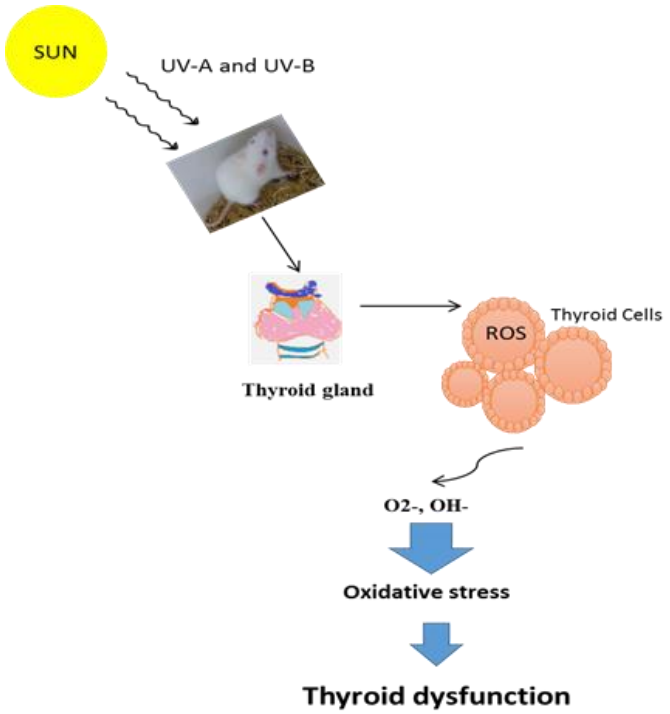

Fig 2: Exposure to UV radiation on rat and thyroid dysfunction by the generation of free radicals.

Thyroid hormones are implicated in the control over the oxidative stress in a very difficult way and the pre-exposition to UV radiation tends to initiate oxidative stress in tissues, the question arises about the effect of the prolonged exposition to UV radiation on animals with hypothyroidism [40]. Ultraviolet radiation was shown to induce a dose-dependent activation of the apoptotic process in FTRL-5 cells cultured in the presence of TSH [41, 42]. In the same cells flown in a stratospheric balloon, a similar effect appeared to be the result of modifications of the nuclear lipid metabolism, that is, augmentation of sphingomyelin degradation and phosphatidylcholine synthesis [43]. Acute and long-term clinical manifestations of radiation exposure include the development of cataracts; damage to the central nervous system, gastrointestinal tract, skeletal system, and blood-forming organs; and increased cancer risk. At high doses, it also becomes an immediate threat to life. Different studies have evaluated the plasma levels of key hormones involved in the regulation of fluid volume, electrolyte concentrations, and energetic metabolism in spaceflights conditions and have found multiple changes in the response of the endocrine system [44], Among these, functional alterations of the thyroid suggestive of hypothyroidism have been documented in both animals and humans [45, 46, 47, 48, 49, 43, 50, 51]. In particular, decreased triiodothyronine (T3) and elevated thyroid-stimulating hormone (TSH) plasma levels have been detected in astronauts during spaceflights compared with prefight values, and both hormones returned to the normal level in the postflight period. Similarly, decreased thyroxine (T4) and T3 plasma concentrations have been shown in rats flown aboard a biosatellite, together with morphological and histochemical changes consistent with reduced thyroid activity, that is, significant reduction of thyrocyte size, accumulation of colloid drops in the cytoplasm, decrease of iodinated thyroglobulin in the colloid, and lower T4 and T3 content per unit of thyroid tissue mass [52].

The thyrotropin receptor is preferentially coupled to the alpha subunit of the stimulatory guanine nucleotide binding protein (Gsα) that activates adenylate cyclase and increases the accumulation of cyclic AMP (cAMP). At higher thyrotropin concentrations, the receptor also couples to the q subunit of guaninenucleotide–binding protein alpha, resulting in the activation of phospholipase C, and there is recent evidence that the receptor may be coupled to members of other G protein families [53]. In addition, insulin-like growth factor I, epidermal growth factor, transforming growth factor β, platelet-derived growth factor, fibroblast growth factor, and cytokines, mainly acting by means of the protein tyrosine kinase signal transduction pathway, stimulate the growth and de differentiation of thyroid epithelial cells [54]. The growth and function of the thyroid are stimulated by cAMP [54, 55]. This second messenger indirectly regulates the expression of the thyroglobulin and thyroid peroxidase genes, whose promoters contain binding sites for the transcription factors TTF1, TTF2, and PAX8 [56]. As a consequence, continued stimulation of the cAMP pathway causes hyperthyroidism (Fig. 3).

Hypothyroidism may develop in patients with cutaneous T-cell lymphoma who are treated with high-dose bexarotene, most likely because the retinoid X receptor-selective ligand suppresses thyrotropin secretion. Retinoid X receptor–selective ligands can suppress thyrotropin secretion, resulting in central hypothyroidism [57].

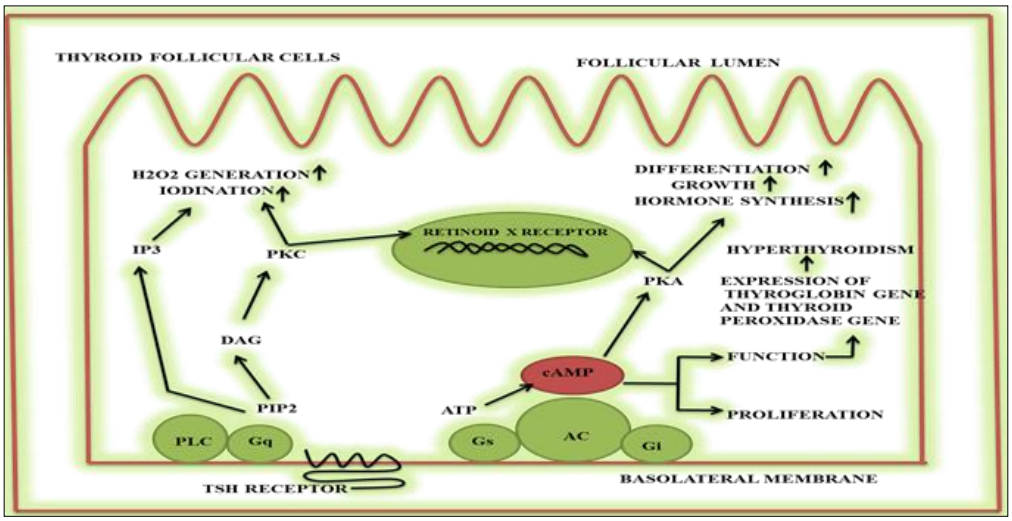

Fig 3: TSH receptor coupled to cAMP and regulated the hyperthyroidism and cell proliferation

6. Radiations and Antioxidants

An antioxidant our well-wisher of damaging cells. Antioxidants inhibit the generation of free radicals and protect the cells. Antioxidants are essential for many enzymatic reactions and also acts as a free radical scavenger. the administration of antioxidants namely Vitamin C, Vitamin E and turmeric significantly increased in the circulating levels of T3 and T4 and this hormones responded to antioxidants representing the significance of antioxidants for the prevention of occurrence of certain diseases in thyroid gland by protecting biological system against potentially harmful effects of processes or reactions that can cause excessive oxidations [58].

7. Conclusion

This review looks at the generation of free radicals by the radiation i.e. ionizing and non-ionizing radiations. Ionizing radiation like x-rays, gamma rays and non-ionizing radiation especially UV radiation generate the free radicals and oxidative stress in the thyroid gland and determined changes in thyroid hormones and their functions. Thyroid hormones are implicated in the control over the oxidative stress in a very difficult way and the pre-exposition to UV radiation tends to initiate oxidative stress in tissues and the effect of the prolonged exposition to UV radiation on animals with hypothyroidism. Many receptors involved the thyroid dysfunctions such as retinoid X receptor-selective ligands can suppress thyrotropin secretion, resulting in central hypothyroidism and TSH receptor (thyrotropin receptor) is coupled mainly to the cAMP pathway by means of the alpha subunit of the stimulatory guanine nucleotide binding protein. The cAMP regulates the manufacture of thyroid hormone and the proliferation of thyroid epithelial cells and thereby mediates hyperthyroidism.

8. Acknowledgments

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